Royal Geological Society of Ireland, Dubl

JOURNAL

OF THE

GEOLOGICAL SOCIETY

OF DUBLIN.

VOL. III.

DUBLIN:

PRINTED FOR THE SOCIETY,

BY SAMUEL B. OLDHAM, 8, SUFFOLK-STREET.

MDCCCXLIX.

JOURNAL

OF THE

GEOLOGICAL SOCIETY OF DUBLIN.

VOL, III. PART I. 1844. No. 1.

AT THE

ANNUAL GENERAL MEETING,

14TH FEBRUARY, 1844,

The following Report from the Council was read :—

IN presenting their Annual Report on the state of the Society, the Council have the gratification of announcing a continued increase in the number of its Members. During the past year twenty-seven new Members have been admitted, but from this must be deducted three, removed by death or other causes, leaving a total increase of twenty-four.

Since the last Anniversary the arrangement of the Museum has been altered, so as to enable the Society to display the valuable additions recently obtained. Several new cases have been provided, and are already filled with important collections of Irish and other specimens.

At the close of the last Session, your Council, fully impressed with the advantage of rendering your collections more available to the Geologist and Geological Student, and convinced of the duty which devolved upon the Society of contributing as far as possible to the public information, while they claimed the public support, took into their serious consideration the best means of accomplishing these desirable objects. They were also anxious, that your Museum should be placed in a suitable condition, previously to the meeting of the British Association in August; and after mature deliberation, they determined on the immediate election of a Curator. They accordingly selected Mr. Oldham, for this important office, and they

have now to congratulate the Society on the acquisition of an officer, whose ability, zeal, and industry, in your service, have more than realized the favourable opinion which your Council previously entertained of him.

Your Council further resolved, that the Museum should be opened to the public, on two days in the week, when the Curator should be in attendance, to afford every reasonable facility for study, or comparison of specimens.

Under these arrangements, your Council confidently state, that your Society is at the present moment in a more practically effective condition, than it has hitherto been: and would refer to the greatly increased attendance at your monthly meetings, as a sufficient proof that already the interest in your Society has increased.

Your Council have more recently issued a circular, announcing these new arrangements to the Members, and, although this has not as yet been as widely circulated as they could desire, they have the satisfaction of knowing that it has already excited much attention to your Society.

In addition to the above, your Council have determined on the formation of a Museum of Economic Geology, in connexion with your fossil collections: and, aware that this was by many considered a rash experiment, considering the very limited funds which the Council could command, they feel a peculiar gratification in being able to report, that this union of practical application with scientific research, has elicited such favour, that the Society is already in possession of collections scarcely equalled in value by any in these kingdoms. To the munificent donation of Mr. Wilkinson you are indebted for a collection of the most important building stones of Ireland, being the halves of the specimens experimented on by him; and also a collection of nearly one hundred varieties of bricks from various localities in Ireland: and to Mr. Radcliffe, for a series of two hundred specimens of the limestones of Ireland, many of which have been examined by him, with a view of determining their cementing properties. These collections will afford an amount of practical information, which no other Museum in these kingdoms can supply.

With regard to your general collection, they would refer to the Report of your Curator, appended hereto.

But while congratulating the Society on their very much improved prospects, your Council would also impress upon you, that these very valuable and important additions to your Museum, entail an additional expense; and they would direct attention to the fact, that the progressive improvement, and increased utility of the Society, cannot be maintained, unless its revenues be increased by an addition to the number of its Members.

The Council cannot conclude without alluding to the very valuable donations which your Society has lately received from Mr. T.

Hutton, in a series of nearly fifteen hundred specimens of minerals, rocks, and fossils; and more recently, a collection of tertiary fossils, from the neighbourhood of Nice, collected and named by Professor Risso. Intrinsically valuable as these donations are, your Council estimate them still more highly, as evidencing the opinion formed by Mr. Hutton, who is personally acquainted with the working of the Society, of the value of your exertions.

They subjoin the Accounts of your Treasurers, from which it appears, that there is a balance to the credit of the Society, to the close of the year, of £4. 2s. 3½d. exclusive of arrears.

Report of the Curator.

At this, the first Anniversary Meeting of the Society, since my appointment to the office which I have the honor to hold, it becomes my duty briefly to report on the state in which I found your collections, the progress which has been made in their arrangement, and their present condition.

It will be in the recollection of the Council, that at the time of my appointment, (in July, 1843) alterations were in progress in the rooms of the Society. The interruptions caused by these works prevented any very satisfactory steps being taken for some weeks. I then found that your collection had become so covered with dust, &c., that it would be absolutely necessary to go over each specimen individually. I succeeded, by some exertion, in accomplishing this, and in bringing the rooms into a state of cleanliness, prior to the Meeting of the British Association, in August. Your Museums were subsequently visited and examined by several Geologists, who visited this country at that time.

My first object now was to ascertain the integrity of the collection, as compared with the Catalogue published by the Society; but I was surprised to find a deficiency amounting to, at the least, one fifth of the number. Most of these I found among other specimens in baskets, and replaced them in the drawers. And as several new species had been described by Mr. M'Coy, as well as the others in the Catalogue, examined and identified by him; and as the principal deficiencies occurred in the Carboniferous series, to which I was aware he had been devoting much attention, I requested his assistance in identifying these specimens. I was anxious neither to make myself responsible for his naming, nor to assume any credit for what he had already done; and I am happy to state, that by his kind assistance, the majority of the deficiencies have been supplied. There are still, however, a few which I hope to be able to supply very soon. The delay consequent on Mr. M'Coy's not being able

to give me this assistance until last week, has left this portion of the collection in a less satisfactory state than I could have wished.

I have also availed myself of every opportunity of adding to your collection, and am happy to be able to state, that it has been in my power to add nearly 300 species to your named series. The principal additions have been in the Silurian, Coal measure, newer Secondary and Tertiary groups. There are, therefore, at present about 700 named species in your cabinet, exclusive of other specimens, which I considered necessary as illustrative of varieties, resulting from age or from local modification.

To the Rock and Mineral collection also numerous additions have been made, and your Economical series already amounts to a considerable number.

The number of species in your Fossil collection is unquestionably very small, if compared with the number of known or described Fossils, amounting to many thousands, or even with the smaller number known to occur in the British isles. Taking the lists of Morris (recently published) as the fullest and most accurate authority on this subject, we find that more than 5200 species have been observed in the British Isles. Of this number, your Museum therefore only contains between one seventh and one eighth. But these 5200 are, it must be remembered, scattered through all the collections in the country, and a much fairer estimate, therefore, of the value of your collection will be had, by comparing it with that of some similar institution; and for this purpose, the last Report of the Geological Society of London furnishes the data. From a detailed list of the contents of their Fossil Museum, it appears, that the total number of species is 1916, or not three times that of the Dublin Geological Society. Now if it be taken into account, that the London Society has existed three times as long as this Society, that it has always had a very large income, and is in the very centre of every thing tending to advance the Science, that for many years past it has had as Curator, one of the ablest Fossilists in these countries, whose health was exhausted by his zealous services for the Society, it must, I think, be a rather gratifying comparison to find, that with the amazingly limited opportunities of this Society, and its very small income, it yet possesses a Fossil collection amounting in number to nearly one third of that of the London Geological Society. Besides, it is fair to suppose, that all the species which have been described, are known and named in the London collection, while, from circumstances to which I shall allude, your drawers contain numerous specimens which cannot at present be identified, but which will unquestionably add many to the number of species.

Necessarily deficient, however, as is the Museum, it yet contains a sufficient number of characteristic and typical species for the purposes of ordinary reference, and in this point of view, it is

the only collection at all available for the Geological Student in this City.

In carrying these arrangements into execution, your Curator has had to labour under the serious disadvantage of having no separate room, in which the unavoidably dirty work of unpacking, dusting, &c. &c. could be done, and the necessity of doing all this in the same rooms in which the cases are kept, has involved much additional trouble.

But the chief difficulty arises from the very defective state of the Library, which is such that it is not possible satisfactorily to identify Fossil species other than those of common occurrence. Nor is this deficiency confined to your Library alone, for there is not a Library in Dublin, public or private, as far as I know, which contains any thing approaching to a collection sufficient for Geological reference.

T. OLDHAM.

CURATOR.

February 12th, 1844.

Abstract of Accounts of the Geological Society of Dublin, for the year ending 8th February, 1844.

Dr.

	£	s.	d.
1843.			
To Balance of last year's Account, ...	22	4	1½
— Admission Fees, ...	6	0	0
— Subscriptions, including two Life Subscriptions of non-resident Members, ...	77	0	0
	£105	4	1½

Cr.

				£.	s.	d.
1843.						
By Furniture purchased, viz.:—						
Cases, ...	£16	7	0			
Lamps, ...	2	14	0			
				19	1	0
— Printing, Stationery, Cards, Summonses, &c.				12	13	10
— Bookbinder, ...				6	6	0
— Engraver, ...				1	10	0
— Painting and Glazing, ...				1	10	4
— Carpenter's work, including Panels for fossils, &c.				3	6	1½
— Lighting, Candles, &c.				1	11	0
— Curator, (six months)				40	0	0
— Incidentals, including Postage, Carriage of Specimens, Delivery of Summonses, Porter's Wages, &c.				11	0	6½
— Collector's Fees, ...				4	3	0
1844.						
— Balance in Treasurer's hands, ...				4	2	3½
				£105	4	1½

N.B.—This is exclusive of sundry arrears.

(Signed)

13*th February*, 1844. Wm. Edington, Treasurer.

Examined, and found correct.

WILLIAM MURRAY, } *Auditors.*
THOMAS OLDHAM, }

February 14th, 1844.

List of Donations presented since the last Anniversary.

TO THE MUSEUM.

March, 1843.—A large collection of Fossil Plants, from the Coal Measures of Newcastle, from Peter Purcell, Esq.

April.—A specimen of Sulphur, from the Granite at Killiney, from James Pim, Jun. Esq. by Robert Mallet, Esq.

May.—A considerable number of specimens of Agates, and silicified woods and corals, from the island of Antigua, from Captain Portlock, R.E.

A series of Fossils from the Carboniferous Limestone of Berwickshire, from the Rev. N. Jenkinson, through Captain Portlock, R.E.

Deposited in the keeping of the Society, Dr. Green's Monograph on the Trilobites of North America, with models of the species.

June.—A large specimen of Bog Butter, found in the Bog of Allen, from John Houston, Esq. M.D.

November.—A series of Carboniferous Limestone Fossils, from various localities; from Thomas Oldham, Esq.

A series of Silurian Fossils, from Pomeroy, Co. Tyrone; from Thomas Oldham, Esq.

Specimens of a peculiar form of Quartz, from Knockmahon Mines, Co. Waterford; from Thomas Oldham, Esq.

Some Fossils from the Carboniferous series at Benburb, from William Murray, Esq.

December.—A large and valuable series of specimens of the most important building stones of Ireland, from Geo. Wilkinson, Esq.

A large Mahogany Glass-Case, and five Geological Charts, framed and varnished, from T. Hutton, Esq.

January, 1844.—A splendid collection of Minerals, Rocks, and Fossils, from various localities; two painted wooden stands with shelves, from T. Hutton, Esq.

Specimens of the Limestones of Ireland, from J. Radcliffe, Esq.

February.—A series of Tertiary Fossils, from the neighbourhood of Nice, collected and named by Professor Risso, from T. Hutton, Esq.

Nearly one hundred specimens of Bricks, from various places in Ireland; from George Wilkinson, Esq.

A large number of Carboniferous Limestone Fossils from Kilmallock, Co. Limerick, from George Wilkinson, Esq.

Specimens of Sandstone, Millstone Grit, and Limestone from the Co. of Fermanagh, from Dr. Collins.

A very large Septarium, with specimens of the Silurian Schist in which it was found, from Hugh N. Nevins, Esq. Waterford.

Two specimens of Limestone, from the Shannon Commissioners.

TO THE LIBRARY.

March.—The Ordnance Maps of the Co. of Waterford; by order of his Excellency the Lord Lieutenant.

November.—The Ordnance Maps of the Co. of Tipperary; by order of his Excellency the Lord Lieutenant.

The Annual Address delivered at the Anniversary Meeting of the Geological Society of London, February, 1843, by Roderick I. Murchison, Esq. President.

On the Classification of the Palæozoic Deposits of North Germany and Belgium, by R. I. Murchison, and Rev. A. Sedgwick; with plates, and descriptions of the Fossils, by Count D'Archiac, and M. De Verneuil; presented by R. I. Murchison, Esq.

System der Krystalle, by M. L. Frankenheim; from the Author.

Indice Ragionata, di alcuni testacei di cephalopodi fossili in Italia, &c.; per Giovanni Michelotti.

Rivista di alcuni specie fossili della Famigli dei Gasteropodi, per Giovanni Michelotti; from the Author.

December.—Report of the Fifth Annual Meeting of the Geological Society of Manchester; presented by the Society.

The Mining Journal for 1843; from the Editor.

After the Reports had been read, it was resolved:—That they be confirmed, and that such parts of them as the Council may think fit, be printed, and distributed among the Members.

The Balloting Glasses having been duly closed, and the Lists examined by the Scrutineers, the following Gentlemen were declared duly elected the Officers and Council for the ensuing year:—

President,

C. W. HAMILTON, ESQ. F.G.S.L. M.R.I.A. &c.

Vice-Presidents.

R. GRIFFITH, ESQ. F.G.S.L. F.R.S.E. M.R.I.A. &c.
JAMES APJOHN, ESQ. M.D. M.R.I.A. Professor of Chemistry to the Royal College of Surgeons, &c.
JOHN SCOULER, M.D. F.L.S. Professor of Geology and Mineralogy to the Royal Dublin Society.
R. MALLET, ESQ. M.R.I.A. Mem. Ins. C.E. &c.
ROBERT KANE, ESQ. M.D. M.R.I.A.

Treasurers,

WILLIAM EDINGTON, ESQ. M.R.I.A.
ACHESON LYLE, ESQ. M.R.I.A.

Secretaries.

H. L. RENNY, ESQ. A. Ins. C.E. M.R.I.A. Assistant Professor of Engineering to Trinity College.
ROBERT BALL, ESQ. M.R.I.A. Sec. Royal Zoological Society of Ireland; Local Sec. Bot. Society of Edinburgh.

Council.

M. M. O'GRADY, ESQ. M.D. M.R.I.A.
JOHN GREGORY, ESQ. C.E.
JOHN MACDONNELL, ESQ. M.D. M.R.I.A.
FRANCIS WHITLA, ESQ.
JOHN RACLIFFE, ESQ. M.R.I.A.
JACOB OWEN, ESQ. M.R.I.A.
JAMES DUNCAN, ESQ. M.D.
WM. MURRAY, ESQ. M.R.I.A. R.H.A.
ARTHUR JACOB, ESQ. M.D. M.R.I.A.
THOMAS HUTTON, ESQ. F.G.S.L. M.R.I.A.
REV. H. LLOYD, D.D. F.T.C.D. M.R.I.A.
GEORGE WILKINSON, ESQ. M.R.I.A.
ROBERT CALLWELL, ESQ. M.R.I.A.
GEORGE DU NOYER, ESQ.
WILLIAM ANDREWS, ESQ. M.R.I.A.

Curator.

THOMAS OLDHAM, ESQ. F.G.S.L.

The President then delivered the ANNUAL ADDRESS.

The cordial thanks of the Society having been voted to the President and Officers, for their zealous efforts in the cause of the Society, during the past year, the Society adjourned.

ANNIVERSARY ADDRESS OF THE PRESIDENT,

JOHN SCOULER, ESQ. M.D. F.L.S. &c.

GENTLEMEN,

The return of our Annual Meeting requires that I should lay before you, a recapitulation of the labours and discussions in which we have been engaged during the past session, and exhibit a statement of the condition and prospects of our Society. As the object of our association is to advance the Science of Geology, not only by the contribution of facts, and observations, but also, to diffuse a more general taste for Geological pursuits, by affording every facility to the student, I shall, before offering any remarks on the papers which have been communicated, take a view of the present state of the Society, with respect to its organization and efficiency.

Since the formation of our Society, and more especially since the apartments in which we now assemble have been so liberally conferred on us, it has been our desire, not merely to contribute to the progress of the Science, by our monthly meetings and discussions, but also to afford every facility to the student in acquiring information. Keeping this object in view, the arrangement of our Museum, and its extension by the acquisition of new specimens, has been steadily pursued, and I am happy to state, that, through the zeal of the Members of the Society, as well as the activity of our Curator, our progress has been very considerable. Possessed of very limited funds, a great pecuniary expenditure cannot be incurred in the acquisition of books or specimens; but this deficiency has been remedied by the numerous and valuable donations of our Members, which have very much extended the amount of our Geological collections. In this department, the thanks of the Society are especially due to the Earl of Enniskillen, for his donations of Fossils from the newer secondary formations of England. It is also my duty to acknowledge the valuable donations we have received from Captain Portlock, R.E., and from P. Purcell, Esq., and also from our steady and active friend, Thomas Hutton, Esq.

Among the most valuable contributions which we have received since the last Annual Meeting, I have to mention one from Mr. Wilkinson, consisting of a very extensive, and well selected series of the different building materials found in Ireland. It will require a few remarks to illustrate the importance and value of this donation. Although the chief object of the Society is to aid in advancing the progress of Science, to illustrate and extend the principles on which it is founded, by exploring the mineral structure

of Ireland, and describing the organic fossils found in its strata, the application of those Geological principles to Economic purposes, is also a legitimate and important object of its attention. No better evidence of the value of Geology to the Architect, the Miner, and the Agriculturist, can be quoted than the fact, that Government has sanctioned the formation in London of a Museum of Economic Geology, in which specimens of building materials are deposited; and in short, where the application of scientific principles is employed to guide and rectify the empirical rules derived from mere details, often only of local importance, and limited use. With a similar conviction of the utility of a collection of Economic Geology, although with very limited means of carrying it into effect, the Geological Society of Dublin has attempted to supply the deficiency so far as regards Ireland, and the very extensive and carefully selected series of specimens presented by Mr. Wilkinson, will form the nucleus of our contemplated Economic Museum.

Before quitting the subject of the Museum, it is due to the Society to mention, that arrangements have been made, by which it is now thrown open to the public, on two days during the week, and that free from all expense to the visitors. To accomplish this, as well as to keep the collections in an available condition, and afford the requisite information to the public, the Council of the Society have appointed Mr. Oldham, Curator of the Museum. Of the fitness of this gentleman for the duty he has undertaken, it is unncecessary that I should say more than that he comes to it with the experience acquired, while engaged in the Geological department of the Ordnance survey; and that the present occupation is one in which his tastes and duties coincide, while his steady industry and excellent business habits render him a truly valuable Officer of the Society.

In procceding to take a retrospect of the papers read before the Society during the past Session, I have again, as on a previous occasion, to regret the deficiency of original communications; but at the same time I have to acknowledge the exertions of many of the Members, who have supplied our meetings with matter for valuable and interesting discussions, tending to render those meetings, in some degree, a school of Geology; and the influx of new Members, above any preceding year, has proved that our exertions have been appreciated by the public.

The first communication which I have to notice is by Mr. Mallet, giving an account of the occurrence of native Sulphur in the granite of Killiney. The discovery of so volatile a substance as Sulphur in a plutonic rock, is a curious phenomenon in Chemical Geology; but in the present instance, it is not free from ambiguity; and indeed, as Mr. Mallet observed, it was more for the purpose of directing inquiry to the subject, than for establishing the fact from the specimen exhibited, that the discussion was brought before the

Society. The only undoubted specimens of native Sulphur found in Ireland, as far as I can remember, were found in fissures of the Carboniferous Limestone of Galway. In this instance, the mode of their formation appears to be capable of an easy explanation. It appears to result from the action of Iron Pyrites upon the limestone and shales; and that this is the mode in which these isolated crystals of sulphur are produced, may be illustrated by experiment. If a specimen of decomposable Iron Pyrites be left resting upon a portion of shale, for a few months, even in a dry room, it will be found that some of the Pyrites has been decomposed, and the shale will be covered with an incrustation of sulphur. By a similar process, we may account for the formation of crystals of sulphur in the limestones of Galway.

The Fossils of the Carboniferous limestone are peculiarly within the domain of Irish Geologists, as the Geological Physiognomy, so to speak, of the country, is derived from the great extent of its surface occupied by that rock. In this respect, the richness of organic forms, abounding in the Carboniferous limestone, is scarcely appreciated by our Geologists, and it presents a boundless field for examination and discovery. I am aware that the subject has, of late, been taken up by Messrs. Griffith and M'Coy, and when their researches are published, we will be able to form some idea of the amount and variety of the Fossil Conchology of Ireland. In these investigations hitherto it has been too much the custom to reduce the study of Fossil shells merely to the formation of a catalogue of Conchology, useful, indeed indispensable to the stratigraphist, but throwing no light on the Science of Zoology, nor illustrating the structure and economy of Fossil Molluscs, by a comparison with living genera and species. The labours of La Marck in this department, have been guided by sounder views, than most of his predecessors. Regarding the study of Fossil shells as a portion of the Science of Malacology, as well as of Geology, he has thrown light upon the general principles of Zoology, without in any degree impairing its value in the investigation of the succession of strata, or their analogies and differences in remote regions.

In this point of view, and not because I agree with him in all his opinions, I have to notice some valuable observations of Mr. M'Coy, on the structure and classification of the shells of the Brachiopode Molluscs. Mr. M'Coy observed that he objected to the views of M. Des Hayes, who had suppressed the genus Spirifer, merging the species it included in the older genus Terebratula. In order to explain the grounds of Mr. M'Coy's opinion, it will be necessary to state, that when we break open specimens of the Fossil genus Spirifer, we find within them the spiral bodies, which have hitherto been considered as the preserved spiral arms of the animal which inhabited the shell. It is well known that in the various genera of Brachiopoda, the animals are, among other characters, distinguished

from the ordinary Acephalous Molluscs, by the possession of these very remarkable spiral appendages; and that the analogous spiral bodies found within the Fossil Shells have been considered to be of the same nature. Beside these spiral arms belonging to the animal, the shells of the Brachiopodes also possess a very curious organization, consisting of several calcareous processes or teeth, for giving support to the animal, or insertion to its muscles. Mr. M'Coy considers the spiral bodies found in the Spirifers, as being analogous to the calcareous processes of the shell itself, and not as the remains of the spiral arms of the animal.

Mr. M'Coy arrived at this conclusion, from the examination of numerous sections, and of siliceous casts, which being immersed in dilute acid, exhibited the internal structure with great accuracy. According to these researches, the spiral bodies of the Spirifer arise from the shell in precisely the same position as is occupied by the internal support in living Terebratulæ; while the spiral bodies, if analogous to the arms of Brachipodes, should have been loose, and separate from all adhesion to the shell, as is the case with the undoubted arms, which are only attached to the body of the Mollusc. In every species which was examined, the arms were perfectly flat, and as thin as writing paper, resembling the supporting processes of the living Terebratulæ; in every instance, they arise on each side of the beak, by a broad flattened space, from which they diverge, converging again towards each other about the middle of the shell, where they give off a short blunt process directed backwards; they then diverge, until they reach the anterior margin of the shell, where they turn backward and towards the beak, forming a number of spiral turns, diminishing in size towards the cardinal angles. Mr. M'Coy further suggested, that the late Mr. Sowerby, in describing the spires of the Spirifer as hollow cartilaginous tubes, may have mistaken the coating of minute crystallization, which usually covers them, for the tube, and the shelly support in the middle, for the hollow. This crystallization, represented in Mr. Sowerby's figures, must have given rise to the singular assertion of M. Des Hayes, that the appendages were articulated, which is not the case, either with the arms of Brachiopodes, with which he compares them, or the spires of any species of Spirifer. As for the remainder of the internal structure of the shells, there are always in their dorsal valve, two strong short cardinal teeth, one on each side of the base of the triangular foramen; they are supported by two thin shelly plates, which Mr. M'Coy names dental lamellæ, extending from the base of the teeth to the beak of the shell, forming the two diverging lines which we see, on grinding down the beak of the larger valve of the Spirifers; between these, there is a longer central septum having no connection with the hinge.

Mr. M'Coy then entered into some details concerning the external structure of the Productæ. He mentioned that in the classification

of the Brachiopoda, which he had drawn up for Mr. Griffith's work, he had restricted the genus Producta to those large hemispherical species, without cardinal area or foramen, which are so frequent in the Carboniferous limestone, and are also found in the Magnesian limestone, but very rarely, if ever, in the Silurian strata. Dalman's genus Leptæna should be restricted to the small flat scale-like species, having a distinct cardinal area, with parallel sides, by which they are distinguished from the small species of Orthis. The genus Leptæna, thus restricted, is of frequent occurrence in the Silurian strata, but rare in the Carboniferous series, and is not found in any newer formation. The angular species of Sowerby's genus Producta have been placed by Mr. M'Coy in a new genus, with the appropriate name of Leptagonia. It comprehends such species as Leptæna depressa, L. analoga, L. nodulosa, &c. &c. having a large cardinal area and foramen as in Orthis, and an internal structure intermediate between Orthis and Producta. This genus has a wide Geological range, being found in the Devonian, Silurian, and Carboniferous strata.

In conclusion, Mr. M'Coy stated his objections to classifying the genus Lingula, with the Brachiopodous Molluscs. The true Brachiopodes have two hearts, while Lingula, like the ordinary bivalves, has only one; all the Brachiopodes are inequivalve, while Lingula is equivalve; the Brachiopodes, when attached, have one valve perforated for the muscle of attachment, while in Lingula, as in Pinna and other attached conchifera, the attaching body issues from between the valves, neither of them being perforated; and finally, the gills of the Brachiopodes are attached to their spiral arms, in Lingula they are attached to the mantle, as in the ordinary bivalves.

I have endeavoured to give a somewhat brief outline of this very valuable communication, in which, if I cannot as yet adopt all the views brought forward, I can fully estimate the scientific spirit, and comprehensive views with which it is replete, and above all, the union of Geological and Zoological discussions, without which, all such investigations must be incomplete and unsatisfactory. The study of Fossil Shells can only be carried on successfully by those who come to the subject with a competent knowledge of the structure of molluscous animals, and of recent Conchology. At the same time, I confess, that with respect to the opinions advanced by Mr. M'Coy, concerning the nature of the spiral bodies, found in the Fossil spirifers, I am still unsatisfied, until their union with the body of the shell, and their identity with the supporting processes of the recent Terebratulæ be more distinctly made out. But, even where the evidence for those opinions is not decisive, at all events matter for future investigation has been afforded, and it is to be desired that Mr. M'Coy will favour the Society with a more elaborate communication at some future time.

The next communication I have to notice, is from our zealous

Secretary, Mr. Hamilton. He exhibited a magnificent series of the horns of the red deer, found in Ballinderry Lake, in the County of Westmeath. These specimens were as is usual with those found in bogs, much better developed than is commonly the case with individuals of the species at present. One of the specimens exhibited had no fewer than nineteen branches, with the double palmation at their extremities, which characterize the animal when arrived at full maturity. Near the place where these remains were found, there is a low marshy point, which projects into the lake. When the soil was turned up with a spade, it was found to contain a vast number of antiques, both of bronze and stone, along with bones, teeth, and fragments of horns of red deer. At either side of this promontory there is a double row of stakes, extending into the lake, and converging to a point near its centre. We may suppose, therefore, that this part of the country was a favorite hunting establishment of the early inhabitants of the country, where the deer were driven into the lake and captured.

It is to be wished, that the attention of those who have opportunities, by residing in the country, were directed to the remains of different kinds, which are of daily occurrence in the marl of lakes, or under the peat in the bogs. By this means, some animals long lost to our Fauna might be restored, or obscure questions cleared up. Thus, for example, the remains of the Irish Elk are of daily occurrence in some parts of the country, and they are often sent to the bone mill, along with common bones. There are, however, many points which might easily be cleared up, on which, at present, we have little definite information. We do not know if the bones of other animals, whether ruminant or carnivorous, are ever found associated with those of the Elk, neither have we any unequivocal evidence that any works of human art, as arrow-heads or stone hatchets have ever been found in the same bed of marl. Among the many curious topics for investigation on this subject, I may mention, that in the beds of recent marine shells, and the stratified gravel beds, which occur throughout the island, we have evidence of its recent emersion from under the waters, and in more recent times we know, from the wood imbedded in the bogs, as well as from historical evidence, that a great part of the surface of Ireland was forest, unfavourable for the existence of an animal encumbered with such immense antlers. Perhaps these circumstances may guide us in ascertaining the limits of the existence of the species, or at all events in pointing out a matter deserving of enquiry.

At the same meeting, Mr. M'Coy favoured us with some remarks on the Echini of the Carboniferous Limestone. He observed that all those large spines and hexagonal plates of the Carboniferous Limestone, which had been referred to the genus Cidaris, by recent writers, were exceedingly distinct from that genus, inasmuch as none of the plates are hexagonal; but they were really allied to the

genus Palechinus of Dr. Scouler, that is, they had more than two rows of interambulacral plates. He had also observed a great many distinct species in the Carboniferous Limestone, for whose reception he had created the genus Archiocidaris, which stands in the same relation to Palechinus, which the true Cidarites do to Echinus.

The next paper which I have to notice, is on a subject which, if not strictly belonging to inductive Geology, is at least intimately connected with a science which has so often to call to its aid the pencil of the artist The communication to which I allude, is from Mr. Du Noyer, and has for its object to illustrate the importance of a knowledge of Geology to the landscape painter, and was enhanced in value by the exhibition of drawings, in which the artist exhibited very happily the value of the principles he laid down. On the contents, however, of this judicious and well written paper, I will not enter into any very lengthened observations, as there is one department of the subject on which I could scarcely venture to advance any elaborate criticism. If a knowledge of anatomy has ever been considered of importance to the sculptor and historical painter, it is equally obvious, perhaps more so, that a knowledge of Geology and of Natural History, must be of the utmost importance to the landscape painter, whose ambition it is to combine scientific truth with the love of ideal beauty. Of the value of this combined study of science and art, it may be mentioned, that the reformation of anatomy, by Vesalius, was cotemporary with the most flourishing period of art in Italy. It is supposed that some of the anatomical plates of Vesalius were designed by Titian; and at all events the great importance of the alliance of science with art is beautifully shewn in the work of the great restorer of anatomy, in which the plates combine the merit of artistic excellence, with correct anatomy. The importance of Geology and Botany to the landscape painter is no less apparent; they teach minute and accurate observation, and, so to speak, afford definite rules for that which, in only a very few minds, is the result of a happy intuition. In like manner, as the eminent artists of Italy made anatomy an object of their study, the landscape artist will cultivate a knowledge of the characteristic features of rocks, either as to form or colour. It is true that, in some cases, these features will attract the attention of the most incurious; every one will be struck with the dark columnar masses of trap, associated with the white chalk of the coast of Antrim; and in like manner, the conical hills of Quartz rock form a marked feature in the admired scenery of the Bay of Dublin. But it is in more minute and nice observations than these, that the artist avails himself of his Geological knowledge, as in the features, for example, which distinguish the calcareous from the schistose rocks; the greater or less rapidity with which rocks decompose, giving rise in one case to the sloping sides and rich vegetation of micaceous

mountains, or in another to the perpetual desolation of the hypersthene valley of Coruisk. It is not, however, by their mineral features alone, but by the vegetation which they support, as indicated by the, so to speak, geological preferences, even of mosses and lichens, that rocks give a character to scenery. Thus Orobanche rubra would be out of place any where except on a basaltic rock, and that artist would betray his negligence, who would venture to represent the fox glove upon any of our calcareous rocks.

It is with much pleasure I quote the following illustrations of these views, from Mr. Du Noyer's paper. Speaking of the Rock of Cashel, with its noble remains of ancient art, situated on the rugged mass of limestone, close to the city, and rising far above the rich plains of the Suir, he says, "On examining the rock with a geological eye, I soon recognized, in the immense mass of limestone, the evidence of the former influence of some upheaving force. To the south, the strata of limestone were perpendicular, then, as they ascended, they became horizontal; and passing northward, at length dipped to that point of the compass." Afterwards, on inspecting an otherwise skilful drawing of the Rock of Cashel, he observed that this characteristic feature, which has given to it the appellation of the Limestone Rock of Cashel, had been completely neglected, the rock being represented as a mass of granite or trap, which had been driven up by the strata. The value of a geological eye to the painter is also well illustrated by an analysis of the various circumstances whose union gives character to the scenery of Antrim. In this district of bold headlands, and precipices of dark columnar basalt, contrasted with the snow-white strata of chalk, the artist may select, besides those prominent characters, which force themselves on the notice of every one, a number of minute, but equally peculiar circumstances. "Looking for objects wherewith to form a foreground, his eyes will rest with delight on some luxuriant plant of the Irish Rose, (*Rosa Hibernica.*) Its dark but glaucous leaves, and large pink flowers, will charm the eye by their colours, and their inestimable quality of harmony with the surrounding scenery. With pleasure he transfers the plant to his canvass, and along with it a snowy boulder of altered chalk, which, from its position and colour, may possess the quality of giving breadth of light to the picture;" and the only risk is, that the mere painter may be tempted, if ignorant of science, to transfer the same features to some remote district possessing very different features.

At a subsequent meeting of the Society we were indebted to Mr. Wilkinson for an account of some fossil wood, which was found at a depth of fifty feet in sinking a well, at Nenagh, in the County of Tipperary. This wood was found in a bed of clay, which was covered by a depth of forty-three feet of irregularly stratified limestone gravel, containing many large fragments of that rock rounded and smoothed from attrition. The wood appears to be yew, and in

all probability transported, as no roots or branches, or any traces of bark were found. It is also of importance to observe, that no shells, or other bodies of marine origin, were found in the calcareous gravel. The conclusion which these facts appear to warrant is, that the wood had been transported, and subsequently covered by a deposit of calcareous sand and pebbles. Whether or not this be considered as the true explanation of the phenomenon, it is at all events desirable that additional instances be observed, and communicated to the Society. Although in the present state of the Science the evidence of the recent elevation of the greater part of Europe, at a comparatively recent period, from under the ocean, is sufficiently established, this very circumstance suggests many subordinate enquiries which have yet to be followed out, and consequently requires new facts and illustrations. In the present example, the occurrence of wood, which appears from the specimens presented to the Society, to belong to the yew, suggests a comparatively recent epoch of elevation, and at all events, conditions of climate similar, if not the same, as those adapted to our present vegetation, and thus the evidence from vegetable remains is in accordance with that indicated by the marine shells on our raised shores, of the prevalence of a cold climate.

I have not hesitated to include the occurrence of fossil wood under limestone gravel, as a proof of elevation, not that, if taken alone, it would be sufficient to prove a change in the relative level of land and water, but because it belongs to a series of phenomena which can be explained in no other way. In the North of Ireland, and also in the Counties of Dublin, Wicklow, and Wexford, we find unquestionable evidences of the elevation of land, in the beds of gravel or marl, abounding in recent marine shells, and I may add, that in addition to shells, I have obtained the rib of a whale from the marl beds of Wexford. It is true that in the case before us, no marine shells were found, but the presence of such remains is not absolutely necessary to prove that a portion of land was formerly under the waters. The occurrence of the stratified banks of limestone or other kinds of gravel evidently involves the sorting power of water, even where marine shells are so frequently absent. Indeed, the absence of shells in by far the greater number of our beds of transported matter, called Eskars or Drumlins, is not very difficult to be accounted for. The nature of the materials of which they are composed, and their irregular stratification appear to involve the conclusion, that they were accumulated in shallow, but turbulent water, little favourable for the abode of molluscous animals. It is also to be remembered, that these porous and loose beds are very unfavourable for the preservation of shells, the water by which they are constantly percolated must act upon the shell, and dissolve the calcareous matter, and the decomposition of the animal matter of

the shell will split it into soft lamellæ, which will soon moulder into a soft and moist powder.

At the same meeting, we were indebted to Mr. Wilkinson, for another, and much more elaborate paper, giving an account of his experiments on the architectural value of the different building stones found in Ireland. These experiments had for their object, to ascertain the absorbing properties of different kinds of rocks, and their resistance to fracture and pressure. Of the value of the applications of Geological Science to practical purposes, no doubt can be entertained, while, reciprocally, facts and principles may require to be discussed, which will throw light on obscure questions in Geological theories. On the importance of Geological knowledge to the Architect, it is needless to insist at any length, nor to state the obvious truth, that a knowledge of the physical structure of a country is a much better guide, when searching for architectural materials, than any mere empirical investigations can be. But a more important branch of Science, in the present instance, is a knowledge of the mineral and chemical properties of different rocks, which may be comprehended under the same Geological term. In this point of view, I need only mention the importance of a knowledge of cleavage; of the mineral characters of the different kinds of granite, some so indestructible, others so easily disintegrated by atmospheric agencies; of the inconvenience of employing ferruginous sand stones. In such cases, even a very elementary knowledge of Geology will enable the Architect to avoid the employment of such objectionable materials, although a judicious rejection of such rocks may involve the expense of a more lengthened carriage, and greater outlay upon working the materials. It is needless to mention instances, which every intelligent traveller must have witnessed, of fine edifices spoiled by injudicious selections. It gives me pleasure to add, that Mr. Wilkinson has done much to prevent the recurrence of such mistakes. He has presented to the Society a most extensive collection of the various building materials found in Ireland, with a statement of the localities where they were found, and the paper which I have to notice may be regarded also as a descriptive catalogue of their properties.

Mr. Wilkinson observed, that the importance of attending to the quality of building stones, will be evident from a reference to buildings in Dublin, and to the already decaying nature of much of the granite in the Four Courts, and many other structures. It is but a few years since the necessity arose of restoring with new masonry, the walls of the extensive building of Trinity College Library, and the walls of the Cathedrals of Christ Church and St. Patrick; in the old buttresses of which latter building, the effects of perishable stone may still be seen. The investigations related in the paper, were made on about six hundred stones, collected from all parts of the country; and the experiments may be classed under three heads;

first, the absorbing power when immersed in water; secondly, resistance to fracture or bearing strength; thirdly, weight necessary to crush the stones. The following are Mr. Wilkinson's chief results respecting the absorbing power of building materials. The size of the stones immersed in water, was fourteen inches long by three inches square. They were placed in water for eighty-eight hours, and were carefully weighed before and after immersion. Of the ordinary limestone of Ireland, the average weight per cubic foot was 170lbs., in a dry state, and the average amount of absorption, one fourth of a pound. A cubic foot of the chalk limestone of Antrim weighs 160lbs., and absorbs three pounds of water A cubic foot of the earthy calp limestone of Dublin, weighs 160lbs., and absorbs from one to four pounds of water. The absorbing power of sand stones varies exceedingly, as might have been expected in a rock that varies from a loosely aggregated granular mass, to a compact and all but impervious quartz; accordingly, the absorbing power was found to vary from nothing up to ten pounds. A cubic foot of granite weighs, on an average, 170lbs., and varies exceedingly in its absorbing powers. The Newry and Kingstown granites absorb a quarter of a pound; the Carlow from one half to two pounds; and the Donegal as much as four pounds. Basalt is by no means a porous stone; the average weight of a cubic foot is 178lbs., and its absorbent power rather less than a quarter of a pound. In roofing slate, the absorption is very small, seldom reaching a quarter of a pound for the cubic foot of slate.

The utility of these experiments in guiding the selection of building materials need not be insisted on; but at the same time, it is to be remembered, that an impervious stone may at the same time be in other respects very ineligible, as, for example, when it contains protoxide of iron; or in granite, what practically amounts to the same thing, plates of mica.

And here, I am desirous of pointing out a consideration which the variously absorbing properties of different rocks suggest to the Geologist. It is well known, that while in some cases the intrusion of erupted rocks among the strata has left the most unequivocal evidence of igneous action, in other instances, we find no traces of those chemical changes, which result from the action of an intense heat. The remarkable discrepancies which we observe in studying the influences of erupted rocks upon the strata, probably depend on a great variety of circumstances; and we would merely suggest, that the different absorbing powers of rocks may be one of these causes. It is obvious, that as rocks are very bad conductors of heat, and often split by cleavage lines and fissures, the water they contain is therefore the great agent by which heat is transmitted through them, and the different degrees of absorbing power in rocks may be one of the measures of the extent of igneous action. When we find the beds of quartz, in contact with granite, but little altered

by that rock, while the more remote calcareous strata are highly metamorphosed, we may readily conclude that the water in the quartz would transmit the amount of heat requisite to change the calcareous strata, while it would produce no effect on the more intractable quartz rock. These observations may be of little value, unless by pointing out the light which may be thrown on Geological theories by a familiarity with the details of chemical arts and manufactures; and the history of erupted and altered rocks is merely the application of chemical theories to the great phenomena of Mineral Geology.

To return to the analysis of Mr. Wilkinson's paper. His second series of experiments relates to the fracture of different kinds of building stones, when employed in various ways, in which their resistance to fracture is the principal point to be considered. According to Mr. Wilkinson's experiments the schistose rocks afford the best stones for resisting fracture. Some of these are stronger when the pressure is applied on the edges of the laminæ, than when applied on the faces. The basalts rank next in strength, then the limestones, and lastly, the granites and sand stones. Fortunately the stone which is the strongest, is also that which affords materials in the most useful forms, for those parts of a building in which such strength is required. The slate rocks in the vicinity of Valentia were commended by Mr. Wilkinson, as possessing many useful properties. Stones can be procured thirty feet in length, four or five feet wide, and from six to twelve inches thick.

The third series of experiments was to ascertain the amount of pressure required to crush cubes of one inch sides. The order of strength in this case is different from that obtained in the experiments on fracture. When subjected to crushing, the basalts were found to have the greatest tenacity; then the limestones, and below these the slates and sand stones. Among the limestones, the calp was found to be one of the strongest, only inferior to the primary limestones of Connemara in strength.

Such is a very brief analysis of Mr. Wilkinson's paper, which is devoted, it is true, to matters of economical interest, but at the same time such researches can only be conducted with success, when guided by sound theoretical knowledge; and when so conducted, they cannot fail to throw some light upon the Science from which they originally borrowed their own. It is also not to be forgotten, that in a Society, such as ours, depending entirely upon the public for its support, and upon a small number of individuals for scientfic contributions, it is of the utmost importance, that from time to time we should exhibit the necessity of scientific principles to control or correct mere empirical rules. In this way the science of Geology is doubly useful, by indicating on the one hand, neglected but available rescources, while, on the other, it is no less valuable by preventing wild and ruinous undertakings.

In bringing my remarks to a conclusion, and in stating my regret for their unavoidable brevity, I cannot but congratulate the Society on its improved prospects as to organization and finance; and at the same time, express my earnest wish that the number of our field observers may be increased. I am so fully convinced of the importance of this, that I should at present consider one of the most important objects which the Society can keep in view, will be the formation of a Geological School in Dublin, by diffusing a taste for the science, and facilitating the means of acquiring information respecting its details, or illustrations of its principles. As I have now to take my leave of you, I have only to express my regret that I have not been of greater service to the Society, in the position in which their partiality had placed me, and for which I had but little time at my disposal It is with much pleasure I now resign to Mr. Hamilton, whose services to the Society date from its first formation, and who has been no less active as an office bearer, than as a contributor, both of valuable specimens to the Museum, and of, what we value more, original observations and communications. And I feel satisfied, that during his presidency the interests of the science will not retrograde among us.

NOTICE.

The Members are requested to take notice, that it has been resolved to alter the form and size of the Journal of the Society, in order to obtain the benefit of the present postage arrangements. The part already issued as VOL. III. PART I. will therefore be considered VOL. II. PART V.; and a title-page for that volume is issued herewith.

The Journal will in future be published regularly during the Session.

March, 1844.

JOURNAL

OF THE

GEOLOGICAL SOCIETY OF DUBLIN.

VOL. III. PART I. 1844. NO. 2.

March 13th—The Earl of Bective, Headfort, Kells; John Phillips, Esq. F.R.S. F.G.S. &c. Professor of Geology, Trinity College, Dublin; Col. Bruen, M.P. Oakpark, Carlow; Evelyn J. Shirley, Esq. M.P. Lough Fea, Carrickmacross; Wm. Smith O'Brien, Esq. M.P. Limerick; James Hans Hamilton, Esq. M.P. Abbotstown, Dublin; John Purser, Esq. Rathmines Castle; and Francis James Farrell, Esq. Baggot-street, were elected Members of the Society.

On the recommendation of Council, the following were elected Honorary Members of the Society, viz.—Roderick I. Murchison, Esq. F. G. S. &c. &c.; Charles Lyell, Esq. F.G.S. &c. &c.; A. De Bouè, F.G.S. France, &c. &c.

A paper, "On the relation of Molecular forces to Geology," by Robert Mallet, Esq. M.R.I.A. Mem. Ins. C.E. Ph. D. was read—

GEOLOGY has been well pronounced by Herschell to rank, in the circle of inductive sciences, nearest to Astronomy, from the magnitude and grandeur of the Phenomena which it seeks to explain, and from the importance of the objects at which it aims, although as yet, and perhaps always, destined to remain, in the precision and certainty of its conclusions, immeasurably distant from the exact sciences, at least from those which are concerned alone with the conditions of "measure, number, and weight."

The first and widest view that we obtain of the general arrangement and superficial structure of our earth, at once discloses the results, in all directions, of two mighty sets of forces in former and in present operation. Chemical forces, acting principally by the aid of heat, and producing the older and lower rocks, or modifying the newer; and Mechanical forces, acting chiefly by the intervention of water, and producing the newer and stratified rocks, or powerfully moulding and remodelling the surface of our present world. The forces of both classes, though often conflicting, are seldom dissevered, but rather are usually mutually reproduced; the instance of this with which we are first and most powerfully struck, is that of the constant restoration of the Mechanical forces of water in motion, upon the earth, by the energy of heat.

Examining with a little more minuteness the chief phenomena presented by the action of these Titanic forces, in the masses they have moulded, we find their distinctive characters so different, that the methods by which they are to be investigated, and even the preliminary knowledge with which their study must be approached, are in each, distinct and characteristic.

Amongst the stratified rocks, and in the mass of matter reposing upon them, we discover the remains of successive worlds, each peopled with its own fitting and peculiar denizens; and each race having prepared, by the inevitable operations of their own economy, the then world, for the abode of their successors, passing away and giving place to the latter, until, as we trace down the long line of creation's ancestry, we find ourselves, at last, cotemporaries with animals and plants living upon the world that now is, whose congeners we also discover imbedded in the rock or the coal-seam, the alluvial bank, or the arctic ice.

To study these, to trace back from the observed habits, qualities, and powers of the living animals and plants that have been given into our hands, those of races of beings long extinguished—beings whose form, appetites, habits, and instincts, so widely depart from those around us, that unless they had been left "engraven on the rock" for our instruction, the wildest fancy would never have conceived of them: to study, systematise, and describe these, demands the highest skill of the Zoologist, the Anatomist, and the Botanist. Yet all this knowledge is but subsidiary, it is but the means to an end.

So on the other hand, when we look a little more curiously into the results presented us by the unstratified and igneous rocks, and in the great centres of Chemical force now acting in volcanic regions, although the impress of organic life is generally absent, we find minerals of every hue and form, metals in various combinations, and existing in veins or courses, all palpably related to the rocks in which they are found, but with a history, obscure and hard to be deciphered, compositions and decompositions going on in the highest degree complex, and forms and structures developed in the masses of the rocks themselves, which demand all the powers of the Chemist, the Mineralogist, the Chrystallographer, and occasionally the Mathematician to explore, arrange, and describe. Yet this, too, is but subsidiary, it is but another part of the means to the great end the Geologist keeps in view—the expounding the machinery, historic, present, and predictive, which the Creator has ordained for the Physical economy of our world.

The Geologist of adequate attainments must therefore not only possess some familiar acquaintance with all these varied branches of knowledge, but must be competent to combine them all in that direction in which we find their objects converging in nature; and by the aid and sure guidance of Physics, must "colligate his facts,"

and build up, of the materials collected from every hand, his *completed* theories.

Thus, then, we most properly regard Terrestrial Physics, the "Physique du Monde," which constitute Geology in its highest sense, as the express history of the movements of a mighty machine, the origin of which is unknown, although its final cause be admittedly Divine; the law of whose motions has at various periods changed, each mutation being preparative to another, each producing results more complex, beautiful, and complete than those of the preceding; each perfect in providing for the enjoyment of its own population of organized beings, while ministering to the fulfilment of that more full and harmonious development of the world's history, when man, made in his Creator's image, was first given the sovereignty of all that had been pronounced "very good" around him.

To solve this great problem—to discover, from the state of the intricate machine as we find it, what have been its former, what are its present, and what shall be its future motions, while it requires all the collateral aid which natural history can afford it, must mainly depend on the power with which Chemistry, and Physics are brought to bear upon its conditions, not widely, and as it were at random, but ever with reference to number and measure; and so that Geology, by its closer acquaintance with these exact sciences, may itself become more exact. The Physics of the ancients dealt in quality alone, it made little progress. Chemistry itself followed in the same track, until, for the first time, Wenzel, and then Lavoisier, thought of asking the question, "how much?" in every case they considered, and Chemistry at once became a science. And who of us is ignorant of the flood of light, which in our own day, the illustrious Liebig has thrown upon Organic Chemistry, upon Animal and Vegetable Physiology, upon Agriculture, by the application of the same method of investigation, by the constant demand of the question, "how much?" in reference to these branches of knowledge, as to which it had never been asked systematically before. And such is truly the fact with respect to Geology at the present hour; the question, "how much?" has been asked as to few, if any, of its great problems. Multitudes of labourers have collected still greater multitudes of facts, but their colligation and explication bear no proportion to their number, or to the labour bestowed upon their collection. Here, however, is the direction in which the future advancement of Geology must be sought—we must cast about for questions, which we may put in the form, "how much?" and these answered by the balance of the Chemist, and by the instruments of measure of the "Physicien," will, we may confidently affirm, throw as great a light upon even its obscurest phenomena, as the same mode of enquiring of nature has done in the other branches of knowledge before spoken of.

The occasions or cases in which we can ask this question are

unquestionably rarer, and harder to be got at in Geology than in other branches of inductive knowledge, because the phenomena are often so vast, as to require long education of the eye and sense, before they can be duly discerned, and their relative importance justly appreciated—because, in many cases, while the final results are before us, the forces which have produced them have long ceased to act, and all traces of their order of action and relative power, have passed away—and because Geology is a science much more of observation than of experiment, and hence, one in which we must look for, but cannot create phenomena. We shall therefore find our most fruitful ground for investigation, by the quantitative method of Geology, in those phenomena which are daily and hourly presented to our notice in the existing state of the globe, and in the consideration of the forces in amount, now in operation, to produce them.

Lyell was almost the first to point out the magnitude and importance of these forces, in daily action, but to how few of them, if any, has the question, "how much?" been applied with system and exactitude. To take an instance—numberless Geologists have pointed out the important bearings, and vast effects producible by the detritus carried ceaselessly down by every river upon the earth's surface, and deposited in the ocean; to a few rivers, singly, measures of the amount have been applied; thus, Sir George Staunton calculated that the Yellow River of China carried down two millions of cubic feet of earthy silt per hour; and Major Rennell, that the Ganges discharges into the Bay of Bengal, three hundred and sixty millions of cubic feet of silt in the same time; a mass, equal, if correct, to more than seventy times that of the great Pyramid of Egypt, hurled into the ocean per day. On the other hand, many Geologists have pointed out lands, either suddenly or gradually elevated, or in process of elevation above their former levels, and shown the probable compensating effect of one of these phenomena to the other; but what combined effort has ever been made by Geologists to measure the volume of water, and the amount of sediment discharged per annum into the ocean by all the great rivers of the world, or even of a single continent, and to fix points, by levellings across the land, by which its actual change of level might be afterwards ascertained, and thus the question, "how much?" applied to both: and so, the sufficiency or insufficiency, or even the necessity for compensation determined.

Here, then, at the outset, we have before us, by way of illustration, a problem as worthy of a great and combined effort of the Geologists of all countries, as that of Terrestrial Magnetism is of the combined labours of Physiciens, and one as rich in promised results to Geology, Meteorology, and many other branches of Physics; while it may be remarked, that in the collection of the necessary facts, by the adoption of one perfect and uniform system,

no impossible expenditure of skill, labour, or money would be requisite.

It is time, however, to return to the immediate object of the present paper. We have already observed, that the vast and ceaseless operations, by which the earth beneath our feet is insensibly changed and remodelled, and that which has "waxed old as doth a garment," fitted to be again subdued and used by man, readily divide themselves into two great classes, namely, those caused by forces purely mechanical, and those whose origin is entirely chemical; and although these rarely, or perhaps never act wholly apart, or without the one class of forces giving rise to, or at least co-ordinating with the other, yet it is convenient in our Geologic investigations to be enabled to consider them occasionally as separate.

Of the Chemical forces, then, we perceive two great divisions also, those acting at a high temperature far beneath the surface, and those dependant on affinities, in play at the common temperature of the latter, while these two sets of forces, by mutual reaction, appear frequently to give rise to a third and different set of phenomena. To fix our ideas, a few illustrations of this class of forces may be adduced.

Excluding from this class of actions, all cases of mere Chemical decomposition, resulting from the reaction and affinities of dissimilar bodies, we have first, cases of Molecular action, in which, by the mere contact of a foreign body not itself acted on, the elements of another are broken up. This may take place either suddenly or slowly; of the former we have instances in Chloride of Nitrogen, ($N\ A_3$) which explodes violently when touched with almost any substance, and is resolved into its constituent gases; Per Oxide of Hydrogene, ($H\ O_2$) Per Sulphuret Hydrogene; and Pelousé's, Nitro Sulphate of Ammonia, which are suddenly decomposed by the contact of various neutral bodies; the former, principally by bodies having an alkaline, or electro positive relation, and the latter, by those having an acid, or electro negative relation to the fluids respectively. Gunpowder in its explosive phenomena, and all fulminating powders, also belong to this class, in which the destruction of equilibrium of the compound and re-arrangement of its elements, is induced either by a change of temperature to a definite extent, or by a shock. Of the latter division, or slow Molecular actions, we have instances in the gradual combinations of Oxygen and Hydrogen into water, under the influence of a plate of clean Platina, or some other bodies; of the conversion of starch into gum and grape sugar, by the action of an acid or Diastase; of Alcohol into Ether, by presence of an acid—the breaking up of Emulsin and Amygdaline into Oil of Bitter Almonds, Hydrocyanic Acid, &c. by mutual reaction—the separation of Sugar into Carbonic Acid and Alcohol, by the action of Yeast—the spontaneous change of Cyanic Acid into Cyamelide, and of Urea into Cyanate of Amonia, the elements being the same in each.

In all cases of the above class, the sensible properties of the bodies are altered; in fact, new bodies are produced; but in another class of Molecular actions, to which all the phenomena of Dimorphism belong, we find changes in the internal arrangement of the molecules of the body going on without any considerable alteration of Chemical or sensible qualities; these changes are more frequently produced by Mechanical than by Chemical actions, and, as in the previous class, they may take place either rapidly or slowly. Of the former, we have instances, of which I here present you with some examples: Rupert's Drops, as they are called, are tears of melted glass, suddenly cooled by being dropped, when in a melted state, into cold water, the surface thus chilled, and instantly becoming solid while the interior is still liquid, is thrown into a state of violent tension, by the unequal contraction of the mass, as are all the particles of the drop in succession; and when cold, the specific gravity of the drop is less than that of the glass from which it is made, in the ratio of 3. 23 to 3. 28 nearly. While the drop continues entire, this state of unstable equilibrium of its particles is preserved; but if a fragment be broken off, or if a scratch be made upon the surface, or if even a violin bow be drawn across the vitreous surface, so as to cause vibration, the equilibrium is destroyed, and the particles fly asunder, with so much elastic force as to produce a slight explosion.

Again, if the alloy of eight parts of Bismuth, five of Lead, and three of tin, commonly called Newton's Fusible Metal, be melted, and suddenly chilled by pouring upon a cold body, on breaking it the moment after solidification, its fracture will be found to be a smooth, silvery conchoidal one, and the metal brittle; in a short time, the metal becomes again spontaneously so hot as to burn the fingers, and when it has again cooled, its Molecular arrangement has become different; it is now tough, and breaks after frequent bending, with a crystalline dark grey fracture.

Again, here is an alloy of about two atoms of Copper and one of Zinc. It possesses very remarkable properties: it is now tough, flexible, malleable, and ductile. If I plunge it for an instant into this solution of Nitrate of Mercury, it is as instantly deprived of all these qualities, and is now so brittle that it may be broken between the fingers. This change may be produced in various other ways, which we cannot now enter into, and is always slowly induced by the action of diluted chlorides, such as sea water, upon it. Common Brass wire suffers a similar change under particular circumstances.

Again, I have here a piece of Iron Wire, it is tough and flexible. I can bend it back and forwards several times without breaking it. Here is a piece of the same Wire, around the circumference of which a mere line has been drawn by the edge of a sharp knife, a microscopically fine nick in fact; yet that nick has altered the

Molecular arrangement of the body where it has been made; the Wire has here become brittle, and I can break it by a single bending. It is by a nick such as this, that a smith breaks a bar of wrought iron cold, with a few blows of a sledge, which he could not cut through in an hour, at a red heat.

Again, if a metal, tough and homogeneous in its structure, such as lead, be heated nearly up to its melting point and broken, its fracture shows that it has now become crystalline; it is in the same relative condition in which floating icebergs, when dissolving in warm latitudes, are often found, to the dread and destruction of the mariner, when the whole mass is made up of great crystalline prisms, so loosely adherent, that the slightest vibration or shock, the firing of a gun, &c. destroys their equilibrium, and the falling masses overwhelm the ill fated ship that may be near, or swamp her in the surge produced by their immersion.

Conversely, again, a metal, or any other body susceptible of crystallizing from fusion, suddenly cooled by contact with a solid of low temperature, assumes a crytallized structure; and in all cases, the principal axes of the crystals are perpendicular to the cooling surface of contact, that is, are in the lines of conducted and radiated heat. Here we have examples of this in chilled cast Iron, and in the unwrought ingot of the alloy of Copper and Zinc we before alluded to. The same arrangement of crystals is observable in the thin seams of trap rock, which traverse other formations—in the dykes of Vesuvius, in the orbicular granite of Corsica, &c. But again, Mechanical action is capable of strangely altering this crystalline arrangement in bodies, such as metals, which admit of change of form by violent pressure. Thus this mass of alloy of Copper and Zinc, if laminated between rollers, and so compressed in a direction perpendicular to the principal axes of the crystals, would have the arrangement of the latter completely reversed, the principal axes of the crystals now following the direction in which the mass is extended, and laying parallel thereto; such is their state in the tough, thin piece I before showed you; and this fact is quite general, to it, is owing the fibrous disposition of the particles of rolled bar Iron, of drawn Wire, &c.

Many other more familiar cases might be adduced, such as the hardening of steel by sudden cooling, when heated red hot; the induction of magnetism in the same bar of steel, by a blow given it in a particular position; the sudden crystallization of Solution of Sulphate Soda, &c. The Molecular changes of this class, however, may also take place slowly: thus, chalk, when slowly baked at an increasing temperature, after it has ceased to lose water, gradually increases in specific gravity, from about 2. 3, to 2. 35, or 2. 4, and may then be cut with edged tools to sharp points or angles, without crumbling, it will no longer write. Lamp-black, by continued gentle heat, never exceeding a low red, passes through a form almost identical with graphite, into a solid, coherent mass, with conchoidal

fracture and glittering semi-metallic appearance, so hard as to scratch glass. The well known contraction of clays, by baking, is another instance.

To this class might possibly also be referred all cases of cementation, such as the formation of steel, by action of Carbonic Oxide on iron; of iron, into Hammerschlag, ($Fe\,O + Fe_2\,O_3$) when exposed, at a high temperature, to Carbonic Oxide and air; the conversion of silver coins, long immersed in the sea, into Chloride of Silver, without any alteration of form, and so forth. But these seem to me rather Chemical decompositions of a peculiar class, than cases of Molecular action.

Having thus somewhat tediously sketched a general classification of Molecular forces in action, I proceed to apply some of their resultant conditions to Geologic phenomena.

Of all the consequences, or direct results of Molecular forces with which we are acquainted, those producing change of volume or of specific gravity, are perhaps the most obviously connected with Geology, and these chiefly affect material substances through the media of Heat, Chemical combination, and Crystallization.

To the first of these is due, the well known circumstances of expansion and contraction of all bodies by differences of temperature; and this is the only case of the operation of Molecular forces which I can find has been applied by Geologists, exclusive of the long observed effects of the freezing of water, and the recent partial attempts which have been made to apply Electricity to the formation of mineral veins, but which, as only acting indirectly, may be viewed more properly as belonging to Chemical forces. To which we may add the revived theory of Metamorphic rocks.

Mr. Babbage, in the year 1834, communicated to the Geological Society of London, his views respecting the effects of the expansion of Granite and other stones by heat, beneath the earth's surface, and by tabulating the rates of expansion, as determined by Colonel Totten, for these and several other substances he proposed to show, that the mere expansion by heat of beds of Granite of vast depth, was sufficient to account, not merely for such slight and partial alterations of level as the temple of Serapis presents, but even for the elevation of the highest mountain chains at present on the surface of our earth. Whatever may be thought of the truth of this deduction, to Mr. Babbage is undoubtedly due, the high merit of first pointing out what may be the startling effects of forces, the most minute and inconsiderable, in the production of motion when applied to Geology.

Mr. Were Fox, at a later period, has published some very interesting investigations, (Phil. Mag. Dec. 1832) in which, by applying the pyrometric determination of the expansions, by heat, of various rocks, to the extent of the fissures existing in them; and finding that these are insufficient to allow for their expansion up to their

melting points, he arrives at the conclusion that these rocks, though generally assumed igneous, have never been in fusion, but have been formed by a slow process of baking. This view, though far from probable, may be supported by many facts. The possibility of vitreous or crystalline rocks being formed without fusion, by the slow baking of the most friable and incoherent material, has been shewn in this place, by the specimens of substances from the interior of iron furnaces, which I have before now had the honour of presenting to the Society, as Quartz rock, thus formed from common rabbit sand; and crystalline rock of Augite and Felspar, formed from fire brick, in the furnaces at Merthyr Tydvil. But Mr. Fox's conclusion is not inevitable from his premises, for admitting the accuracy of his measures, we know of several substances which continue to contract while melted, but expand at the moment of congelation, as, for instance, Cast Iron, Antimony, and Bismuth.

The state of our knowledge as to the changes of volume, which many substances are known to undergo, and it is probable all do undergo, both in the act of chemically combining, and in changing their states of aggregation, or in the arrangement of their molecules, as a branch of Physics, is lamentably deficient. It is known as a fact, that a great number of substances in combining, increase in volume, and on the contrary, that many decrease in volume.

We have also various facts observed of increase and decrease of volume, produced by change of aggregation or atomic arrangement; but so scattered are these facts, so unmethodized, and so unconnected by any appearance of a law, that I have been enabled to condense into a single sheet nearly all the *certain* information we have upon the subject. This I have reduced to five separate tables. The first contains a list of bodies known to expand in volume, in combining. The second is a list of bodies known to expand in volume, in changing their state of aggregation or arrangement, but without combination. The third is a list of bodies known to contract in volume, by combination. The fourth is a list of such bodies as are known to contract in volume, by change of aggregation or arrangement. And the last is a list of such bodies as are known to retain their volume, unaltered by combination.

No. I.

Bodies known to EXPAND in volume by COMBINATION.

Substances. &c.		*Ratios.*			*Authority.*
Antimony and Iron,	alloy,	..		..	Gellert.
Antimony and Zinc,	..	..		..	Gellert.
Copper and Lead,	..	..		..	Kraft.
Copper and Silver,	..	10.200	:	10.351	Cavallo.
Gold (11 pts.) and Iron, (1 pt.)	..	1000	:	1004.7	Gellert.
Gold .. and Nickel, ..	..	1000	:	1007.	Hatchett.
Gold .. and Cobalt, ..	..	1000	:	1001.	Wasserberg.
Gold .. and Lead, ..	..	..		..	Hatchett.
Gold (11) and Copper, (0.5)	..	1000	:	1024	Hatchett.
Gold and Palladium,	..	..		..	Chenevix.
Gold and Silver,	..	..		..	Hatchett.
Gold, Copper, and Bismuth,	..	1000	:	1027	..
Gold, Copper, and Lead,	..	1000	:	1031	..
Gold, Copper, and Silver,	..	1000	:	1024.8	..
Platina and Silver,	..	..		..	Lewis.
Sulphuric Acid, with 4 to 9 atoms water,				..	Thompson.
Sulphate Lime, (Plaster on regaining its combined water,)					..
Lime, on becoming Hydrated,		1.50	:	1.83	Vicat.
Barytes, Stroutran, &c. on becoming Hydrated,				..	Fourcroy.
Iron in passing to the Intermediate Oxide,					Mallet.
Intermediate Oxide of Iron in passing to Peroxide,		1.000	:	1.236	Mallet.
Iron in forming Carburet. (Steel)		7.823	:	7.843	Thomson.
Sundry neutral Salts on complete mutual decomposition, as Chloride Calcium + Sulphate Soda,		1.000		1.00072	Mallet.

No. II.

Bodies known to EXPAND on changing their state of arrrangement or aggregation.

Substances, &c.	*Ratios.*			*Authority.*
Many Crystals in forming, as—				
Rock Salt, - - -	..		..	Brard.
Sulphate Soda, - - -	87	:	89	
Sulphate Iron, - - -	..		..	Mallet.
Sulphate Lime, - - -	..		..	..
Cast Iron, Antimony, - - -	..		..	Reaumur.
Bismuth, - - - -	100	:	101.9	Marx.
Cast Steel, in hardening, - -	7.747	:	7.823	Thompson.
Grey Cast Iron, when "chilled,"	6.91	:	7.71	Mallet.
Prince Rupert's Drops, -	3.23402	:	3.2763	Brewster.
*Zinc, - - - - - - -			-	Ure.
*Lead, permanent expansion by frequent heating,			-	Mallet.

* It may be questionable whether this does not arise from the imbibition of a minute portion of Oxide of the metal, in which case, these should belong to Table, No. 1.

No. III.

Bodies which are known to CONTRACT on COMBINATION.

Substances, &c.	*Ratios.*	*Authority.*
Copper and Tin, (12 Cu. + Stn.)	1000 : 750	Briche.
Cadmium and Mercury, (2 Hyd. + Cd.)	denser than Mercury !	Stromeyer.
Silver and Tin, - - - -	.. ..	Gellert.
Silver and Mercury, - -	denser than Mercury !	..
Gold and Antimony, - - -	1000 : 987	Hatchett.
Gold and Zinc, - - -	1000 : 997	..
Gold and Bismuth, - - -	1000 : 988	..
Gold and Tin, - - - -	1000 : 981	..
Sulphuric Acid, + 1, 2, or 3 atoms water,	- -	Thompson.
Muriatic Acid, Nitric Acid, Acetic Acid, } + Water, - -	- -	Thompson and Ure.
Alcohol, + Water, - - -	- -	Blagden.
Almost all Gases and Vapours in combining; (condensation sometimes enormous, as in Deutoxide Hydrogen)		Therrard.
Some Salts in dissolving in water; as—		
Chloride Calcium, - -	- -	Vauquelin.
Nitrate Potass? - -	- -	

Note.—To this class may be added all cases of condensation of volume, in gases absorbed by porous or finely divided bodies, as Carbonic Acid and Hydrogen, &c. by Charcoal; Oxygen, by Platina Mohr; Ammonia, by Sesqui Oxide of Iron, &c. &c.

No. IV.

Bodies known to CONTRACT in changing their state of arrangement or aggregation.

Substances, &c.	*Ratios.*	*Authority.*
Devitrified Glass, Reaumur's Porcelain,	3.750 : 3.276	Mallet.
White Cast Iron, made in refining,	7.684 : 7.068	Thompson.
Gold cast under great pressure,	17.364 : 17.035	Hatchett.
Cast Iron, under similar circumstances,	7.94 : 7.70	Mallet.
Copper, and probably all other metals so treated,		..
Various Clays, on drying and baking,	.. ..	Wedgewood.
Oxide Chrome, and various others, on heating,		Wöller.
Various Salts in crystals, on cementation, as—		
Sulphate Barytes, - -	- -	
Sulphate Lime, - - -	- -	Mallet.
Plaster of Paris, on imperfect crystallization, when baked at 350° Fah. with its pores filled with water,		Chantry.
Precipitated Gold and other metals, on heating below fusion,		Lewis.

No. V.

Bodies, whose volume is known to remain unchanged in combination.

Substances, &c.	*Ratios.*	*Authority*
Lead and Tin alloy, density mean in all proportions,		Watson.
Copper and Bismuth, do.	do.	Gellert.
Various Super and Sub-Salts in combining when mutual decomposition is incomplete, - - -		Mallet.
Some Gases and Vapours in combining, - -	-	

In these lists, scanty as they are, some of the determinations are now for the first time published; these are principally those relating to the changes of volume in neutral salts, by neutral decomposition.

The principal Philosophers who have hitherto treated on this branch of Physics, are Hatchett, in his papers on the Alloys of Gold; Dr. Lewis, on Platina; Bishop Watson, in his Essays on the Density of Saline Solutions; Blagden, on Mixtures of Alcohol and Water; Reaumur, Hassenfratz, and Vauquelin, in the Annales de Chimie; and Doctor Ure, in the Journal of Science; with Marx, on the Expansion of Bismuth; and Dr. Thompson, recently, on that of Sulphuric Acid.

Some of the cases of expansion and. contraction in volume, contained in these lists, are extremely curious, for instance, Copper and Lead, when alloyed expand; Copper and Tin contract, while Lead and Tin suffer no change of volume; so that the metals, Lead and Tin, seem to produce opposite effects upon the same metal, Copper, and when themselves combined, neutralise each others' powers.

The expansion of Steel in hardening, of Grey Cast Iron when "*chilled*," and Prince Rupert's Drops, have been already in part explained, in describing the phenomena attending the bursting of the latter bodies.

Whenever a nodule of vitreous rock, such as those described in the Transactions of the Royal Irish Academy, as constituting the structure of the Great Galway Whin Dyke, which, though distinct, bears so close an analogy to that of the Orbicular Granite of Corsica, or those glassy nodules ejected by volcanoes, and known as volcanic bombs, with which Humboldt describes some parts of the plain of Quito to be covered, and which are also well known about Vesuvius —whenever such a nodule is suddenly chilled upon the outside, as by falling into or being projected through water, or by rapid flight through the air, a structure more or less completely analogous to a Rupert's Drop, must be conferred upon it. The effect of the powerful tension of its particles, in virtue of which the specific gravity of the mass is so much reduced, by the forcible distension and tendency to separate the molecules, must greatly increase the facility of re-arrangement of the particles of the interior of the mass while still fluid; and it is probably in virtue of this, that we find the substance of every orb of the Corsican Granite, when cut in half, to consist of concentric crystalline rings, varying in composition, the Hornblende being principally outside; the fan-like rays, also, which the larger orbs present, bear a striking analogy to those which are developed by the action of light in Rupert's Drops, and which have been so well described by Doctor Brewster. May not some similar cause explain hereafter, the singular fissured flints found in such numbers in the lower beds of Chalk, in England? nodules which, although laying compact and undisturbed, and closely embedded in undislocated Chalk, are yet, on extraction, found to consist merely of an immense number of closely

fitting pieces, separated by scarcely visible fissures, whose general direction is either parallel to the curved surface, or radial to it.

To speculate a little further in this direction, it has been repeatedly remarked, by the observers of volcanic eruptions, that of the enormous numbers of incandescent masses thrown from the crater, few, comparatively, appear to reach the ground, while the enormous volume of volcanic sand which accompanies their ejection, and is partly precipitated in a continuous shower during the eruption, of which much remains suspended in the air, and is carried to vast distances, has also been described by all. May it not be possible, that a large portion of this finely divided, but still'angular and sharp sand, then, is formed in the air, or rather in the thick cloud of dust and smoke above the crater, by the sudden fracture of the vitreous masses launched from its mouth, and rapidly cooled by their swift flight through the air, and thus separated into the minute fragments which you have seen a Rupert's Drop does.

The inconceivable rapidity with which a heated mass is cooled in passing through the air, has been shown by writers upon Gunnery; and there is, on mechanical principles, the utmost difficulty in accounting for the projection, to any height from the crater, of small particles of sand, by any explosive force however great, from the great relative resistance of the air. To the other explanation, which supposes the sand raised merely by electrical disturbance, there seem many difficulties. When precipitated to the earth, it is stated to be positively electrical, and such is the condition in which the fragments of Rupert's Drops are found, the moment after fracture. It is to be regretted, that Humboldt does not appear to have tried, whether the large glassy nodules he found on the plain between Bagota and Quito, would fly to pieces on being fractured by a blow: but even though their amount of tension might not be sufficient to produce disruption, the fact of its existence, under such circumstances as above, cannot be doubted, nor hence the analogy to Rupert's Drops. These are but conjectures, yet as they are guesses directed by a principle, they are not the useless "mera palpatio," against which we are cautioned by Bacon.

A directly opposite effect to expansion, namely, condensation of volume, seems to accompany crystallization, when it results slowly from cementation, or long continued heating, of which there are instances in Reaumur's Porcelain, baked Plaster of Paris, melted Chalk, &c.

The force, also, with which some of these expansions take place is remarkable. Vauquelin, in the fourteenth volume of the Annales de Chimie, in his paper on the Expansion of Salts in Crystallizing, states, that strong glass globes were frequently burst by him, by the included salts in crystallizing. And Brard has successfully applied the expansive energy of Sulphate of Soda, as a test of the durability of building stone, by causing the specimen to absorb the

saturated solution, which, in crystallizing, disintegrates portions of it in the same way that water does in freezing. And we see every day masses of Pyritose, or alum slate, split to pieces by the formation of the crystals of their respective salts; and large masses of Granite split by the formation of Oxide of Iron round bars inserted into them. The expansion of Lime in slacking, takes place with such force, as to be capable of bursting a common malleable Iron Mercury bottle, when slacked in it. It has been proposed as a substitute for Gunpowder in blasting, and were there not insuperable practical difficulties in the way, from the short range of its expansion, it would, so far as power is concerned, effect the object.

There are many reasons which induce the belief, that the saliferous system of Britain is a Chemical formation; that its beds of Rock Salt, of Gypsum, and of Marl, have not resulted from simple deposition from saturated solutions, but from Chemical decomposition, or replacement and subsequent deposition. Want of sufficient data prevents us discussing this difficult subject advantageously; but it may be mentioned, that the extreme rarity of marine exuviæ—the constant co-existence of Rock Salt and Gypsum—the frequent coloration of both, by the Sesqui Chloride and Oxide of Iron—the non-existence of Bromine or Iodine in the Sal Gemme, while both it is said, are found in the Brine Springs—and the occurrence of Salt Beds in the green sand, and Oolitic Limestone formations, as well as with us, in the red marl; all tend to favour the Chemical theory of the formation. To these may be added, that Prof. Nicol found Solutions of Chloride of Magnesium, and Chloride of Calcium, in cavities of the crystals of Sal Gem, (Edin. Phil. Journ. New,) and Dumas has found Carburetted Hydrogen in their cavities, in a highly compressed state.

Now I have found, that when saturated solutions of Chloride Calcium and Sulphate Soda mutually interchange elements, the two Salts undergo an expansion of volume, amounting to one, one hundred and fortieth of their bulk; and that when the intermediate Oxide of Iron is converted into Per Oxide, an expansion of volume takes place, in the ratio of 1. : 1. 23.

The present known depth of the Salt formation of Cheshire, is, Salt beds, about 300 feet, and Gypsum beds, with the red and blue marl, 160 feet; while it is highly probable, as stated by Bakewell, that the total depth of the formation is above 700 yards. If, then, we assume, that this depth of Salt and of Gypsum, resulted from mutual decomposition, and that the 20 per cent. of Per Oxide and Prot. Oxide of Iron, which the red marl on an average contains, was once all in the state of intermediate Oxide, then the surface of the strata will, on the completion of these changes, have been elevated by this mere expansion in volume alone, by about eight feet six inches, supposing the increase of bulk prevented from taking place laterally, and confined to the vertical; but if the expansion be equal

in all directions, then the amount of elevation would be, quam proxime, one third of the above height. This amount it may be objected, is too insignificant to form part of any question of Geological change of level; but it will be recollected, that it is an application of the principle to a mere scratch on the earth's surface, in point of depth, and that even so, it is sufficient in amount to produce many important results of superficial elevation, and is above half the extent of elevation of the Temple of Serapis at Pozzuoli. I do not mean to assert that these cases of elevation are due to this cause, or even that in the case of the Salt formation, the phenomena described have actually taken place. I merely wish to illustrate the occurrence and effects of a force which must be in frequent operation, and which, although, in the present state of Geology, impossible to be often recognized, must, in a future stage of its progress, form an element of correction in every calculation of Geologic change of position. Let us illustrate this a little further, by considering the effects due to Molecular action alone, which would result, from assumed changes of temperature, in the Chalk formations of Kent and Hampshire, the tertiary of the Paris Basin, and in the London clay. Let us suppose such a depression to take place, or any other cause that should considerably elevate the temperatures of these formations; and first of the Chalk. Under pressure, at a dull red heat, Sir James Hall found it might be slowly converted, without loss of Carbonic Acid, into crystalline marble of the Rhombic form of crystal. The density of the Chalk is on the average, 2.315, that of white marble in large crystals is = 2.723. The contraction in bulk will therefore be as those numbers inversely, should such a change be effected. Now the depth of the Chalk formation of Kent is about 600 feet, a depression of surface, therefore, to the extent of no less than 89 feet, perpendicular, would be produced by Molecular change alone, and this, supposing the whole mass of the chalk at liberty to contract alike; but if enough of intermobility be assumed, so that the whole contraction shall affect the depth of the strata by subsidence, then the thickness of the present 600 feet of Chalk would be reduced to about 338 feet in thickness of marble. Now as to the Paris Basin, let us consider the effects of change of Molecular condition upon its beds of Gypsum. The following table gives the relative density of Sulphate of Lime in its several states:—

Plaster of Paris cast. $Ca\,O + S\,O_3 + 2\,H\,O +$ Aq.	1. 30
Gypsum $Ca\,O + S\,O_3 + 2\,H\,O$,	2. 30
Johnston's Salt, $Ca\,O + S\,O_3 + \frac{1}{2}H\,O$,	3. 10
Anhydrite, $Ca\,O + S\,O_3$	2. 85

Let us suppose the beds of the Paris Basin heated to 300° Fah. at which temperature the Gypsum loses constitutional water, and afterwards exposed to the percolation of moisture. The density of the mass will diminish in the ratio of 1. 3. to 2. 3. or allowing for

compression by superincumbent matter, say as 1. 5. to 2. 3, Now in the absence of information as to the actual thickness of the formation, let us see the effect upon a depth of Gypsum of 100 feet. An elevation of surface will result of 53 feet, for every hundred feet in depth of formation, if the expansion take place equally in all directions; but if assumed, as would be the fact only to take place in the vertical, the elevation would be 15+4 feet, upon 100 in depth of original formation, or the 100 feet in depth would become 254 feet.

In fact, were the Paris basin depressed, under cover of detrital matter, until its temperature reached 300° Fah. and water then gained access to it, there can be no doubt but that the expansive energy, and heat extricated, would produce an earthquake, or temporary volcano.

Now let us further suppose, that afterthis vast expansion in volume, (which has been such, as we observe, that the original depression of strata producing the effects, would be much more than obliterated in the subsequent elevation due to this enlargement) suppose now the depression to continue until the mass should reach a low, red heat, the amorphous mass of plaster would pass back again into Gypsum in crystals, as was observed by Chantry, the eminent sculptor—and finally into Anhydrite, also crystallized; but Anhydrite is denser than Gypsum, in the ratio of 295 to 230, so that thus the mass would gradually shrink back to its original dimension, and then fall below it, until at last the original 100 feet of Gypsum would remain only 78 feet in thickness of Anhydrite.

Lastly, to apply the same principle to the London Basin—the depth of clay here is about 650 feet—the average specific gravity of the London clay is 2. 1. At a temperature just approaching redness, it is baked into a soft brick (known in London by the name of place bricks) and whose specific gravity is 2. 5. Now if we suppose the London clay, either by subsidation, or otherwise, exposed to this temperature, the depth of the strata, now 650 feet, would shrink to 546 feet, or a depression would result of 104 feet, besides the formation of fissures of great extent, by the lateral contraction throughout the whole mass of the clay.

These instances of the vast results which may be produced in the motion of masses, by mere Molecular change, I have taken, without any regard to the Geological probability of their occurrence, but simply as cases, capable from the existence of the requisite data, in measures, of illustrating the principle in view—a principle which will be found to apply to very many circumstances actually occurring both in the sedimentary and in the igneous rocks.

Expansion produced by Molecular change may affect not only the original mass, but produce also the most powerful effects of disruption in those adjacent to it, or superimposed. Thus the effects of the expansion of a comparatively soft mass in rending opposing surfaces,

is well exemplified in the process of undersetting the foundations of walls, with what is termed concrete, now so much in use amongst engineers and architects. It is a compound of clean pebbly gravel, with water and hydraulic lime, used hot, as it is called, or before it is hydrated. This mass in the act of consolidation, and especially if hot water be used, swells considerably, and with such irresistible force, that Mr. Godwin, in his Prize Essay, in the Transactions of the Institute of British Architects, states, that he has seen a thick and lofty wall rent from top to bottom, by its expansion. This property, which renders it so suitable for undersetting buildings, obliges certain precautions to be taken when so used, to prevent the above destructive effects from following.

An every day existent case of Molecular change producing powerful and striking effects, is well known to engineers whose operations have lain in the new red sand stone, or red marl of Lancashire, Cheshire, and other counties to the south of these. Throughout this formation there exist great beds, and veins of a blue or rather purple marl, which has the property, when first cut into, and exposed to air and moisture, of expanding considerably: the result is, that it is nearly impossible to make it stand in embankments at any slope; and when freshly dug out, and used as filling between walls of masonry, they have been frequently overthrown by its expansion. This I witnessed in progress upon the Manchester, Bolton, and Bury Railway; and its properties in embankments are forcibly alluded to, by Telford, in his account of the Ellesmere and Chester Canal, where it caused him much trouble.

The explanation of the phenomena appears to be thus—the purple marl contains a large quantity of the intermediate oxide of iron ($Fe\,O + Fe_2\,O_3$) produced, no doubt, by the deoxidation of the per oxide, in certain localities by the infiltration of water charged with organic vegetable matter in a certain stage of decomposition. When this marl is freshly exposed to air and moisture, the intermediate oxide is partially reconverted into per oxide, with increase of volume, as before alluded to. The volume is also increased by the intersusception of water. When it is recollected that rain water generally falls carrying with it from twenty to thirty per cent. of free oxygen in the air it holds in combination; the energy and rapidity of the change of this minutely divided Oxide, in constitution and in volume, will be readily understood. The amount of the expansion in this case has never I believe been measured; for want of the answer to this question, therefore, we can only see that it does act as a Geologic agent of motion, but are unable to determine to what extent.

There is but one other instance, that I am aware of, on record, of Marl possessing this property, viz. that of the clay which is found to constitute nearly the whole bottom of Lake Superior, which, when brought up and exposed to the air, becomes immediately indurated

in so great a degree, as to require a smart blow to break it. This clay is a dense marl, found of different colours, red, blue, and white, and like that above alluded to, effervesces slightly with acids. It is not noticed, in the account as quoted by Mr. Lyell, from the Transactions of the Literary and Historical Society of Quebec, whether the volume is increased or not.

When this increase of volume does take place in a mass already partially solidified, the effects of the compression, in producing union and integration of its parts, must be prodigious. This is beautifully illustrated by the effects of consolidation and coherence, produced upon the impalpable particles of nearly dry porcelain clay, by sudden and forcible compression, in Mr. Prosser's (of Birmingham) patent process for making the Tesseræ of Mosaic Pavements, &c. By a sudden blow from the plunger of a coining press, upon the powder of clay placed within a mould or die, such coherence is given to it before baking, that it is with difficulty broken in the hands, and scarcely shrinks at all in the subsequent firing.

Pouillet, in his "Elemens de Physique Experimentale," has given an account of the singular effects produced by weight and affinity together, in causing the adhesion of glass plates, when newly laid together, when the forces causing union are confined to act in one plane; we may readily conceive, then, the increased solidifying effects of pressure, when thus propagated within the mass, from particle to particle, in every direction at once, and in it find, possibly, a cause for the firm adhesion of the new red sand stone, and other similar rocks, in which the particles of silex are united by a cement of red marl which has expanded betwixt them. The experiments of Mosander, on the reduction of Peroxide of Iron to Protoxide by Hydrogen, or its reduction by organic matter, united with the beautiful views of change of temperature produced in strata during their formation, by the rise or fall of isogeothermal surfaces, proposed by Herschell and Babbage, leave it far from impossible that the whole of the Peroxide of Iron, now in the new red sand stone, may have once been in the state of Protoxide, or of intermediate Oxide, and that by higher oxidation and increase of volume, internal pressure has been produced, which converted the marl and sand, when in suitable proportions, into stone. But in the case of marls and clays where this process goes on, it must frequently proceed from centres of action, as when the causes of oxygenation are local, and in such cases, change of *relative position* of the particles must result, which gives a conceivable solution to the capricious contortions and convolutions of strata, found in the variegated marl of the London Basin, and in various shales. But this leads me further to apply this principle of expansion of volume to the explanation of the Quartz veins found traversing Granite.

From the generality of the fact of expansion taking place during crystallization—from the circumstance that Granite fused into a

glass per se, is much denser than before it lost its crystalline form—and from the fact, that Granite is denser in proportion as it is more confusedly and finely crystallized, I infer that its constituents expanded on crystallizing. Playfair, in his illustrations of the Huttonian Theory, has given cogent reason for believing, that its three constituents have crystallized successively, from a state of mingled fusion; while the examination of the Granite of Portsoy, of Daouria, (by M. Patrin,) and even of our own Kingstown Granite, show that the order of crystallization was, the Felspar first, the Mica next, and the Quartz last, which is found moulded to the crystals of the two former, and in which they have crystallized as in a pasty mass.

The existence and conformation of the Quartz veins traversing our Kingstown Granite, for instance, are so familiar as to need no description; they are in close union with the crystallized Granite, of every thickness, from a sheet of paper to a yard or more; they frequently contain a very little Mica and Felspar, in crystals entirely isolated, and run in all conceivable directions, in surfaces approaching to planes, and crossing each other. In other cases, however, it is to be remarked, as in the large grained Granite of Arran and Cornwall, these contemporaneous veins, as they have been called, are far from being as distinct and well defined as in our Kingstown Granite, instead of which, they appear as long, irregular, ramifying portions, containing an excess of Quartz, and passing gradually without any distinct boundaries, into the average composition of the rock.

Now each of the constituents of Granite, the Quartz, the Felspar, and the Mica, is a definite compound, while the Granite itself is not so, being very variable; and if we consider the average mixture of Granite to be twenty parts Felspar, five parts Quartz, and two parts Mica, in agreement with most Geologists, then on comparing the chemical constitution of the Kingstown Granite, with that of its constituents, it will be found that there is a considerable residual excess of Quartz, constituting the veins in question. Further, as the crystallization of Granite has resulted from cooling, the progress of crystallization must have been from the surfaces cooled towards or into the mass. Now if the Felspar crystallize first, it will take up such a portion of the silex as is due to its own composition, and by expanding as it crystallizes, will push the still pasty Quartz in a direction contrary to that of the cooling agent. The Mica, in crystallizing next, will do the same, and finally, such portion of the Quartz as is entangled amongst their crystals, will crystallize too, leaving the residual quantity pushed into the still hottest part of the mass, to form a Quartz vein, which may be in any direction, according to the position of the cooling surfaces; and will have its form likewise dependant upon these latter, in some degree.

Another view of the formation of these veins may be taken, by

supposing that while the contraction in cooling of the whole pasty mass produced rents or fissures, the expansion of the successively formed crystallized masses squeezed out the Quartz into fissures, until they were full. But I prefer the former view, as better accounting for the various cases of intersection, or "or cross strikes" of these veins, which are quite inexplicable on the theory of these veins having been filled by injection from below, subsequent to the consolidation of the Granite itself; and also better agreeing with the phenomena of the indistinct veins in the Cornish and Arran Granite.

It is to be remarked, that there have been instances cited, of the crystals of Felspar being moulded to the Quartz, as well as of the much more prevalent case, where the Quartz has been moulded by the Felspar; but as contemporaneous veins, both of Quartz and Felspar are found to exist, and even to co-exist, this circumstance does not affect the probability of the view here advanced. The curious separation of the crystals of Lead, from the whole mass of the natural alloy of Lead and Silver, in Pattinson's refining process, presents several analogies to this view of Granite veins.

So far I have endeavoured to show how this force of change of volume may act as a force of elevation, applied to the sedimentary strata, and as an agent of formation in the igneous rocks; it remains to show that it also acts occasionally as a force of disintegration or of degradation.

If it be true that Granite in crystallizing expands, it is in all probability equally true of all crystallized igneous rocks; and hence we should expect to find more or less disruption of the sides of whin dykes, and attendant on their crystallization in their beds, unless, indeed, the contraction of the mass, by cooling, previous to its crystallization, should have caused it to part off from the walls of the dyke, in which case, if the amount of crystallizing expansion was less than the amount of contraction, from cooling, a space would be left void; but as the facts are, that dykes are almost always in precise contact with their walls, although often not united to, or passing into them, the presumption is, that the cause of this precise filling, notwithstanding the contraction from the cooling of the dyke, and the receding of the walls from it from the same cause, must be the expansion of volume of the fused mass, at the moment it assumed the crystalline form.

If igneous rocks, in the act of crystallizing, thus expand at all, they must do so in their largest masses, and as Mr. Babbage has shown, that although the expansion of Granite is so small, as to need accurate instruments to discern it, yet the raising of the temperature of a mass of Granite, 500 miles in depth, by 500° Fah. would elevate its surface nearly thirteen thousand feet; so, as circumstances can easily arise, (or have arisen in a former condition of our planet) in which the sudden crystallization, and as sudden expansion, of enormous masses of Granite, or other pyrogenic rocks, may have

taken place, we perceive, that this apparently minute, and little regarded force of crystalline expansion, may be productive of most formidable dislocations in the substance of the masses, and produce fractures which, from the uniformity of the force, would probably present all the regularity of cleavage.

To this view may be added another consideration of further developement of Molecular force. The discovery of Mitscherlich, that crystallized bodies, belonging to certain systems of crystallization, expand, by heat, unequally in the direction of their different axes, and that some actually contract in one direction, while they expand in another, is no doubt familiar to many here present. This fact renders it highly probable that bodies which expand in the act of crystallizing, expand, then also, unequally in opposite axes; for the same arrangement of particles competent to produce the former effect, would produce necessarily the latter. Thus it may hereafter be found, that this unequal expansion and contraction in the three co-ordinates of igneous and other crystalline rocks or slates, at the moment of solidification from fusion, or during the gradual progress of consolidation after sedimentary deposition, has been extensively connected with the phenomena of their lamination and cleavage, which so often present the characteristics, upon a colossal scale, of forces allied to crystalline ones.

Over miles of country (as, for instance, in the slate districts of the South of Ireland) we find these lines of direction of cleavage, and planes of lamination, pursuing their respective courses, with a mathematical precision that admits of no diversion from changes of surface, of level, or of depth. The suggestion is forced upon the mind, of the presence of a mighty pervading force, acting profoundly within the mass, obviously connected with the Molecular arrangements of its particles, and by the strict reference to a determinate bearing or direction, as to north and south, of its resulting lines of separation, apparently also in connexion with some of the great pervading terrestrial forces—Heat, Magnetism, and Electricity, which affect our Globe as a whole. Thus the cleavage and lamination of rocks, or other crystallized masses, may become hereafter the *point d'appui*, from which we shall connect more closely these mysterious agents, with the forces directing cohesion and crystallization, and perhaps with gravitation itself.

On the other hand, if the temperature, of, suppose a large bed of Gypsum or crystalline Marble, be considerably changed, it seems probable, that the unequal expansion thus produced would give rise to fissures and clefts of considerable regularity, and whose magnitude and direction through the mass would necessarily depend upon the amount of inequality of the expansion, by heat, in the respective axes or co-ordinates of the mass.

Some such forces as these, seem necessary to explain the singular fissures which traverse the coarsest masses of the old red sand stone

in the South of Ireland, cleaving, with the keenness of a sword cut, not only through the ferruginous cement, but through the body of the rounded Quartz nodules imbedded in it.

It would be an object of high interest to determine, instrumentally and with accuracy, not only the prevailing direction of these clefts, and their relation, if any, to the lamination of cleavage of their neighbouring slate, but upon the much wider ground of interest before adverted to—to determine the directions of lamination and cleavage of all the known slate districts in various parts of the world; it would then appear whether their directions are determined by some relation to the form and position of the mass, and the neighbouring bodies, and perhaps with reference to temperature, (as seems unquestionably to be the case in ice, in the act of slowly thawing,) or whether the lines of lamination or cleavage of all the slate upon the globe, have been subordinated to some great and universally constraining Cosmical force. Systematic observations in this matter have not hitherto, to my knowledge, been proposed or attempted.

That a moderate increment of temperature has been the principal agent in developing the cleavage structure in stratified rocks, there is then great probability. The most remarkable examples I have seen of its development are in the Lias shales around Mont Blanc, in the valley of Chamouni, which present all the lithological characters of primary slate, and for which they have been repeatedly mistaken. These same beds are found at a distance with totally different characters.

The action of this force will also enable us to explain some cases of degradation, upon a small scale, of an atmospheric character, otherwise difficult of solution.

The Yorkshire flag stone, which is a fine grained, lamellar, yellow sand stone, when first taken from the quarry, is so soft, as nearly to be cut with a hatchet. It gradually indurates by the action of air and moisture, and in common thin flags the induration is nearly uniform, but when it is cut into larger blocks, and wrought, through its laminæ, into mouldings, or other complex forms, it in course of time desquamates, parallel to the wrought surface, and across the natural beds of the stone. The same effect is produced if this sand stone is suffered to get perfectly dry, by being kept under cover, while still exposed to the changes of temperature due to the usual range of our seasons. Thus the Yorkshire flagging of the Piazza of the Library of Trinity College, will be observed in process of desquamation, while similar flags exposed to wet and to the weather, suffer no such change. The Architect may learn from this observation, that Yorkshire flags are badly applied for internal or covered work, where they always soon become rough and uneven for want of moisture, if at the same time exposed to vicissitudes of temperature. The cement of this sand stone is argillo-calcareous,

and on examining the desquamated portion with a lens, it will be found that this cement has become crystallized, instead of existing, as in the interior of the stone, in the state of a paste; and the specific gravity of the split-off portion is less than that of the interior of the block. I do not pretend to explain the fact of how this is prevented by moisture. This curious circumstance is by no means confined to the Yorkshire sand stone, it takes place with the white sand stone (or grind stones) of the coal measures, with Magnesian Limestone, and with the "Molasse" of the Continent, and is occasionally observed in some varieties of the Black Calp of the County Dublin.

A like explanation may be given of the continued exfoliation of the onion stone of the Giant's Causeway, which is not due to frost, inasmuch as it takes place just as rapidly when the spheroid of the stone is exposed to air and moisture, in a room which is never so low as 32°, as in the open air it arises from change of Molecular arrangement, induced by change of Chemical constitution.

It may possibly be objected to these views of crystalline expansion, that disruption is inferred in every case of mineral crystallization, but that veins and geodes are found filled with contents highly crystalline, yet presenting no symptoms of expansive force. It will be recollected, however, that these are usually (as, for instance, the Septaria) filled gradually, and that hence the expansion of no part of the crystalline deposit can produce rupture, for want of a fulcrum, except the last, which completely fills up the cavity, the amount of expansion of which must be extremely small, as compared with the bulk of the whole mass; and that, moreover, it is not certain that *all* crystals do expand in forming; and lastly, that this disruption can never occur unless the expansion exceed the elastic limit of the material.

Where Capillarity unites with forces of the class we have been considering, very remarkable Geological effects also may be produced, Dalton ascertained, many years ago, that Lime was less soluble in water, at 212° F. than at 60° F. in the ratio of 778. to 1270. I find the same to be the case, though not in the same ratio, with Carbonate of Lime and Sulphate of Lime, when in solution, either in pure water, or in that containing Carbonic Acid. Now suppose a fissure, extending half a mile or so in depth, in a stratified or crystalline rock, and that either by direct infiltration, or by capillary action, water, at the surface temperature, find its way down into it, holding, in solution, Carb. or Sulph. of Lime; as soon as the fluid has reached the depth due to its boiling point, or rather, as I find, has reached 190° Fah. the Carb. or Sulph. Lime begins to deposit, and fill the fissure; let the conditions be such that it shall crystallize, and finally fill the vein, afterwards capillarity and pressure will still force downwards fresh portions of the solution, and fresh coats of crystals form, and each expanding in its turn, when solidifying, with an irresistible force, may separate by insensible degrees the walls of

the fissure, and that which was at first a mere chink, may become, in the lapse of ages, a thick bed of crystallized matter, such as the great veins of Carb. Lime, &c. we find traversing the slates.

We might largely extend these considerations, if we connect Molecular forces with Electrical disturbances, such as result from the contact of dissimilar formations, at the junctions of which thermal springs are almost invariably found; or from the discharge of highly elastic steam and water, as from the Geysers of Iceland. We might also, did time permit, trace its relations with the properties of those elastic bodies, found pent up in the cavities of minerals, or of formations, such as the Fire damp of the coal beds, and in the crystals of rock salt, &c.

Nor are Molecular forces probably wholly unconcerned in modifying the relations of organized beings to Geology. During the two extremely wet years, 1841 and 1842, numbers of dead fish, and others still living, but diseased, were found floating upon the surface of the Grand and Royal Canals, and of many Lakes and other waters in Ireland, where no obvious cause could be assigned for their mortality. I attributed it to the unusual and superabundant supply of highly oxygenated water, brought down in rain, and poured into their abodes. Whether this be correct, I leave to Zoologists to say, without venturing to discuss the matter, in which my Physiological knowledge would be insufficient, and the rather as this paper has already exceeded my intentions as to length.

The views brought forward on this occasion are to be regarded in the light principally of illustrations of the existence, and possible effects of an obscure, but still important class of Geological forces, rather than as descriptions of actually occurring manifestations of them.

In estimating the relative importance of the many forces actuating so vast a machine as our Globe, it is often difficult at first to decide upon their respective value; and those which sometimes appear insignificant, when measured by our every day experience, only receive the just stamp of their position and importance, when we have applied measures to their effects. We would do well to bear in mind, in this matter, the philosophic remark of Seneca, on one very analogous—"Magna ista, quia parvi sumus, credimus: multis rebus non ex natura sua, sed ex humilitate nostra magnitudo est."

I commenced with an opinion as to the uselessness of accumulating facts, without a guiding and arranging theory. I fear it will be now retorted that I have built up a theory, with few facts to which to apply it; and while the existing state of Geology renders it necessary to admit this, as partly true, it is to be hoped, its future progress as a more exact science, will render necessary, as corrections in its deductions, this class of Molecular forces, which, as related to Geology, I was, so far as I kuow, the first to endeavour to put in a prominent point of view, in a paper upon this subject, read several years since to the Royal Irish Academy.

Dr. KANE gave an account of analyses which he had made of the iron stones of the Coal districts of Ireland.

The iron stone of the Lough Allen coal field is found abundantly in the beds of the streams, in nodules which have been liberated by the gradual disintegration of the rocky strata. The ore is also found in situ, forming beds or layers, often of very considerable extent. The nodules of iron stone were found to yield, from the analysis of three specimens :—

	I.	II.	III.
Protoxide of Iron,	53.65	54.42	51.52
Lime,	..	2.23	.69
Magnesia,	..	2.02	1.55
Alumina,	1.00	1.43	..
Insoluble Clay,	12.43	8.65	15.50
Carbonic Acid,	32.92	31.25	30.74
	100.00	100.00	100.00

When these ores are ignited, they lose in weight about 30 per cent.; the exact amount of loss, and the quantity of metallic iron each specimen contained was—

	I.	II.	III.
Loss by roasting,	31.5	30.9	30.7
Content in Iron,	41.7	42.3	40.0

Of the iron stone in veins there were two specimens analyzed, they gave—

	I.	II.
Protoxide of Iron,	47.28	49.94
Lime,	1.26	3.75
Magnesia,	2.23	3.79
Alumina,	1.59	0.87
Insoluble Clay,	18.46	9.08
Carbonic Acid,	29.18	32.57
	100.00	100.00

These specimens gave—

Loss by roasting,	32.14	29.80
Content in Iron,	37.74	38.80

As none of these were picked specimens, the average of all of them is considered by Dr. Kane, to represent fairly the material available at Lough Allen, on the large scale, and the mean of the above five analyses gives—

Protoxide of Iron,	51.36
Lime,	1.59
Magnesia,	1.92
Alumina,	.98
Insoluble Clay,	12.82
Carbonic Acid,	31.33
	100.00

And this contains 40 per Cent. of Metallic Iron.

The loss by calcination, the iron being supposed to remain as protoxide, should be in average 31.33 per cent. and the calcined ore should consist in 100 parts of

Iron, - - - - - - -	58.2
Oxygen, - - - - - -	16.6
Lime and Magnesia, - - -	5.1
Clay, - - - - - - -	20.1
	100.00

These analyses being made solely with technical objects, several points which should have been of interest, in a purely scientific point of view, were not examined by Dr. Kane; thus in such ores, a little iron is always as peroxide, which was not separately estimated, and the carbonic acid is reckoned from the loss, not by a specific determination. Of these ores, Dr. Kane found the 1st, 4th, and 5th to contain a small trace of Manganese; the second and third were totally free from that metal.

The Coal fields of Leinster and Tipperary contain also abundant beds of clay iron stones, of which Dr. Kane analyzed two specimens. They consisted of

	I.	II.
Protoxide of Iron, - - - - -	51.08	48.03
Lime, - - - - - - - - -	.16	1.51
Magnesia, - - - - - - - -	1.05	4.24
Alumina, - - - - - - - -	1.86	1.45
Insoluble matter, - - - - -	13.92	16.17
Carbonic Acid, - - - - - -	31.93	28.60
	100.00	100.00

These analyses were made with the same object, and under similar conditions, as those of the ores of the Lough Allen district.

It is interesting to compare the contents of these ores in iron, with that of the ores of the different localities of Great Britain, where the iron manufacture flourishes. From the data supplied by the best authorities, Dr. Kane concludes, that 100 parts of ore give of metallic iron—

	Natural state.	Roasted.
Richest Arigna Ore, - - - - -	42.3	61.4
Poorest, - - - - - - - - -	37.7	53.2
Average, - - - - - - - -	40.0	58.2
Common Staffordshire, - - - - -	28.0	40.4
Richest, - - - - - - - -	40.5	60.0
Ordinary Welsh Ore, - - - - -	31.4	44.7
Richest, - - - - - - - -	42.1	60.0
Ordinary Glasgow Ore, - - - - -	31.6	45.8
Mushet's Black-band, - - - - -	41.0	63.1
Average Kilkenny Ore, - - - - -	38.7	55.3

There is hence no doubt but that the ores of the Leinster and Connaught Coal Fields, are equal, and even, in average, superior to those generally employed in Great Britain.

The Coal field of Tyrone is not rich in clay iron stone, but Dr. Kane having obtained specimens of nodular Brown Hematite, which was thrown up in large quantities, from the working of the pits at Coal Island, submitted a specimen to analysis. It consisted of

Peroxide of Iron, - - - -	80.79
Water, - - - - - -	11.97
Magnesia, - - - - -	.27
Insoluble Matter, - - - -	5.81
Oxide of Manganese, - - -	1.16
	100.00

This ore should hence have given, by appropriate treatment, 57. per cent. of iron, or from 35 cwt. of ore a ton of iron. This mineral has the formula $2\ Fe_2\ O_3 + 3\ HO$. which is given by the above analysis when the foreign matters are excluded.

This composition is fully equal to the best class of deposits of this ore, by which so many of the iron furnaces of France and Germany are supported.

Specimens of the several ores examined, and of the black or Mushet's band of Glasgow, and of the ordinary Welch ores, were presented by Dr. Kane to the Society.

April 10th—Mr. Oldham, Curator, read a Report on the collection of Fossil plants in the Museum of the Society. It appeared that there were now in the Cabinet of the Society eighty species in all, of which fifteen belonged to the newer secondary formations; the remaining sixty-five being from the Coal measures. These had nearly all been added to the Society's collection during the past year, previously to which they only possessed five named species of vegetable organic remains; and they were principally indebted to the donations of the Earl of Enniskillen, P. Purcell, Esq. and Dr. Scouler for these specimens. A detailed list was given, as follows, (the names only being here printed, and the alphabetical order being adopted for the convenience of reference.)

Alethopteris Lindleyana,
" lonchitica,
" Mantellii,
" Sauveurii,
" Serlii,
Artisia approximata,
Asterophyllites foliosus,
Bechera grandis,
Bornia equisetiformis,
Bruckmannia? grandis,
" longifolia,
" tuberculata,
Calamites arenaceus, (Keuper)

Calamites approximatus, (var $\alpha\ \beta\ \gamma$)
" cannæformis,
" Cistii,
" cruciatus?
" dubius,
" Lindleyi,
" nodosus?
" pachyderma,
" ramosus,
" Steinhaueri,
" Suckowii

Caulopteris gracilis?
Cyclopteris digitata,
„ dilatata,
Cyperites bicarinata,
Favularia nodosa?
tesselata
Fucoides furcatus?
„ hypnoides?
„ intricatus,
„ Stokesii (Solenhofen)
Halonia ——?
Knorria?
Lepidodendron dilatatum,
„ elegans,
„ gracile?
„ selaginoides,
„ Sternbergii,
Lepidophyllum lanceolatum,
Lepidostrobus pinaster,
„ variabilis
Lycopodites falcatus?
Neuropteris flexuosa,
„ heterophylla
„ Loshii,
„ tenuifolia,
Palæozamia pecten,
Pecopteris abbreviata,
„ arborescens,
Pecopteris gigantea (Alethopteris)
„ lobifolia,
„ Miltoni,
„ muricata,
„ oreopteridis,
„ plumosa,
„ Williamsonis,
Pinites Withami,
Pinnularia capillacea
Pterophyllum comptum,
Sagenaria Lindleyana
Sagenopteris Phillipsii,
Sigillaria alternans
„ elongata,
„ leioderma,
„ lævigata,
„ mammillaris,
„ oculata?
„ reniformis,
Solenites Murrayana,
Sphenopteris affinis,
„ artemisiœfolia,
„ distans?(nearGlasgow)
„ linearis,
Stigmaria ficoides,
Tœniopteris major,
„ vittata,
Walchia Williamsonis.

The nomenclature adopted here is that used in Mr. Morris's Catalogue of British Fossils, in which the synonyms and references are fully given. It was hoped, that the deficiencies in this list, as compared with that of Mr. Morris, would be supplied by Members of the Society, or kindred institutions, who might be in the vicinity of the coal districts, or other plant-bearing formations.

On the bones of oxen found in the bogs of Ireland, by Robert Ball, Esq. M.R.I.A. &c. Secretary of the Society.

The Author, in presenting to the Society specimens of casts of skulls and horns of oxen, found in the bogs in various parts of Ireland, briefly noticed their peculiarities. Some years since (vid. Proceed. Roy. Irish Academy, Jan. 1839,) he had directed the attention of naturalists to this extinct species, intending to illustrate its relations more fully at a subsequent period. More recently, on forwarding a cast of a skull in his possession, for the examination of Professor Owen, it was found to be so like a skull in the Hunterian collection, the history of which was unknown, excepting that it was believed to have come from Ireland, that Mr. Clift supposed the cast had been taken from Hunter's own specimen. The species was remarkable for its very short horns, which were projected

laterally and downwards; and for the great length of forehead, between the insertion of the horns, and the orbits of the eyes. From this latter circumstance, Professor Owen, in his report on British Fossil Mammalia, presented to the British Association at their late meeting in Cork, had given the name of *Bos longifrons* to the species. Mr. Ball stated, that his principal object on the present occasion was to direct the attention of the Members, and of persons who might have more leisure than he could command, to the examination of the bones found in excavating the new bed for the River Liffey, for the improvements now being made opposite to the Royal Barracks in Dublin, and among which he believed would be found some bones belonging to the species which he had just described.

JOURNAL

OF THE

GEOLOGICAL SOCIETY OF DUBLIN.

VOL. III. PART I. 1844. No. 3.

May 8th—Frederick Leckie, Esq. Ballykeely, Carlow; and Wm. T. Mulvany, Esq. Dove House, Blackrock, were elected Members of the Society.

A paper was read "On the Trap rocks of Limerick," by C. W. Hamilton, M.R.I.A. F.G.S. President of the Society.

Mr. Hamilton commenced by expressing his opinion, that hitherto sufficiently close enquiry had not been directed to the examination of the origin and order of superposition of the altered rocks in this country; and feeling that the same dependence on outward appearance and lithological character, which had proved such a bar to sound progress in the classification of the sedimentary rocks, would also prove an equally great drawback as regarded these rocks, he ventured to point out some localities in which it appeared to him that some confusion still existed.

The County of Limerick is principally a limestone plain, interspersed with trap rocks. Mr. Weaver (G. T. Vol. 5, Part. 1) had described it as "constituted of seven or eight great alternating beds of limestone and trap." Dr. Apjohn (Journal Geol. Soc. Dub. Vol. 1, page 28) next denied that the trap was stratified, and said that Mr. Weaver's conclusions were "entirely unsupported by facts." He also described the limestone as lying on the trap which had elevated and disrupted it. Mr. Ainsworth, in a further account of these rocks, read before the same Society, expressed his opinion that some of the traps were altered arenaceous rocks, and others effused in beds or dykes. (Jour. Geol. Soc. Dub. Vol. 1, page 112.) Dr. Scouler in the same Journal, (Vol. 1, page 185) denied that the trap rocks have sent forth any dykes or veins, or have spread in sheets over the country, but thought the detached masses have all been elevated after they had acquired some solidity, and in every case protruded through the limestone. In Mr. Griffith's Map, these rocks, in all their varieties, are comprehended in one class, described in his explanatory synopsis by the comprehensive and all-fitting terms

of "Trap Breccias, Metamorphic Breccias, Porphyritic Wackes, with occasional Greenstone and Greenstone Porphyry, which have been erupted"—a description which would apply to all or any of the previous varying opinions.

Mr. Hamilton regretted that he had not been able to see all or even some of the most interesting of these localities, but in those he visited he had not seen any evidence of protrusion, or of that violent action which in some disturbed districts elevates, overthrows, and tosses the strata in every direction, confusing the mind of the observer; in almost every instance the so called trap bears distinct evidence of a sedimentary character, and is conformable to the *subjacent* limestone, the dip varying from 10° to 24° and in the sections which he had made, he found a general and striking similarity in the specimens taken from the same portion, relatively to the junction of the lime and trap in the different localities.

At Knockfierna, near Ballingarry, in passing along the strike from the grit of the western part of the ridge, he found that the rocks, forming the summit of Knockfierna, held the same direction, and consisted evidently of an altered conglomerate, with the pebbly beds and the sedimentary lines on the sandy beds distinctly marked. He saw no junction of the limestone, but there was no reason to doubt the accuracy of Mr. Griffith's reference of the range to the old red sandstone; if so, the summit instead of being erupted trap, is either metamorphic old red, or a contemporaneous deposit of a different character.

Sections were made at Grange, near Lough Gur; on two parallel lines crossing the two western eminences of the range of hills, S. & W. of Caherconlish, in the townlands of Knockroe, and Knockroe, (Mason); at Cahernarry, and at the well known Castle of Carrick O Gunnell. Upon comparing the specimens from all these, Mr. H. found so remarkable a similarity, as to lead him to reduce them to three classes, occupying the same relative position in each of the sections. 1st—The underlying limestone, light grey in colour, dolomitic, very crystalline, and in some places full of chert nodules. The mode of weathering is peculiar: on the exposed surface it decomposes into rounded hollows, and irregular cavities, which have all the appearance left by the falling out of pebbles from a conglomerate, but which must depend on some concretionary structure, as the fresh fracture does not display any such distinction. Near the trap, the rock is more crystalline, and through it are developed imperfectly pronounced crystals of a green mineral, which fuses easily before the blowpipe, and appears to be an augite. Where the rock is weathered it is obvious that these are crystals but imperfectly marked; there are also small crystals of brown spar numerously disseminated through the mass. At Lough Gur a bed of limestone was found close to the junction with the trap, dark grey in colour, granularly compact, with crystalline fragments and fascets; fracture

irregular and uneven; before the blowpipe, a fragment fuses into a dark enamel, with minute spots through it, proving the admixture of some more fusible mineral with the Carbonate of Lime. Resting on this is a very dense petrosiliceous rock, finely and granularly compact, fracture approaching conchoidal; the colour where freshly broken is a dark blueish grey, but where exposed it becomes of a lighter yellowish grey; it is fusible before the blowpipe. On the north of Knockroe, there is a quarry of encrinal limestone, shale, and grit in alternation, dipping at a low angle under the trap of the hill of Knockroe East, and having on its strike the traps of Knockroe West. This quarry cannot be mistaken for any thing but the Calp, though it can only be a very thin bed of it, as it lies immediately upon the purer limestone, and is as quickly succeeded by the traps.

The second class includes the rocks which have been described as trap breccia. It is sometimes a distinctly porphyritic rock, the paste being a confused aggregation of a dark green mineral of earthy aspect, which has much of the appearance of coarse serpentine, (and has been so called by Dr. Scouler) but which readily fuses into a dark enamel before the blowpipe, and contains, minutely disseminated particles of Carbonate of Lime. In this paste are imbedded many crystals of whitish felspar, and a few small fragmentary particles of quartz; through the paste may be traced darker spots which have all the flakey structure and lustre of Hornblende, but which graduate insensibly into the ordinary speckled paste. The rock is irregularly laminated, and on the weathered surface has a pebbly aspect, from the different degrees of facility with which the ingredients decompose.

In a quarry near Cahirnarry, may be seen beds of limestone, followed in perfect conformity by others, having all the outward appearance of the alternating shales and impure limestones in a Calp quarry, but on breaking off specimens, the limestone is found to graduate into the green paste identical with that just described, and still containing encrinal remains. At Carrig O Gunnell, the same position is occupied by a rock of more brecciated appearance, containing irregular masses of limestone, green paste, and Carbonate of Lime, crossed in every direction by crytallized Carbonate of Lime. The similarity between this, and specimens taken from a Calp quarry, suggested a similar origin; and Mr. Hamilton thought that the brecciated or conglomerate appearance might be owing to some cause affecting the rock, while in its original position, and not to the agglomeration of fragments once separated, and then cemented together.

The next bed in the ascending order apparently differs little in composition from the last, but the outward appearance is marked by a redness in the colour of the paste, owing probably to some admixture of iron; the greenish paste is still visible in some places. It is

also more calcareous, and the crystals of Carbonate of Lime, which are thickly disseminated, give it a mottled appearance, which the most minute specimen exhibits under the microscope. The weathered surface has all the appearance of a sedimentary rock, and whether the finer striæ of some beds, or the conglomerate appearance of others, be owing to pebbles included in the original deposit, or to irregular concretions dependent upon the different composition of the beds, they tell as clear a story of gradual deposition as the unaltered conglomerates of the old red sand-stone. In this rock were seen many instances of large limestone blotches, passing gradually into the substance of the rock, as in the quarries at Knockanea, and on the Dublin road, two miles from Limerick.

On the summit, on each of the hills of Knockroe, Mr. H. found a mixture of felspar and crystals of hornblende, and the same in the northern side of Carrig O Gunnell Castle; the undisturbed character of the other strata, and the marks of sedimentary lines upon the weathered surfaces forbid the idea of this being a trap, erupted from the centre of the mountains.. If we consider the probability of all these different beds being merely those, which in other parts of the county occupy the same position, as lying over the lower limestone, only altered by some impulse which has disturbed the molecular arrangement, and given birth to new chemical combinations, we shall certainly meet with some difficulties; and one of the chief is, that what we imagine to be the last step in the metamorphic process, namely, the production of syenitic greenstone, occurs in the uppermost of the overlying beds, while the alteration graduates downwards until it reaches the apparently but little altered limestone. This may be answered by the conjecture that some of the beds were by nature more susceptible of change, that the limestone when pure, assumed only a more crystalline structure, but that the shales and impure limestones of the calp series, containing Lime, Magnesia, Alumina, Silex, Iron, and an Alkali, *(if fusibility infers its presence)* presented all the materials of the porphyries and syenites. It may also be answered by the supposition of these beds being the deposit of a volcanic ash, ejected over the waters of that ocean, from which, in other parts of its bottom, have been deposited the cotemporaneous or equivalent beds of the calcareous mud which formed calp.

In 1838 Mr. H. examined the district lying between Newry and Dundalk, and described, in the Dublin Geological Society, the different changes which have taken place there, and which follow in this succession—the slates graduate into syenites: first, the rock loses its granular texture, and becomes compact, it wears a ribband appearance from the alternation of lighter coloured hornstones; when these are examined under a lens they seem translucent, and contain little nebulæ, as it were, of dark green spots; before the blowpipe these spots yield, first, into a black enamel, and then the

translucent substance yields with a greater or less degree of heat, and melts into a whitish enamel. The progress of these spots may be traced until they appear as well developed crystals of Hornblende. Other beds assume a granitic appearance; but the most interesting are the Porphyries of Forkhill, which were then coloured by Mr. Griffith, as erupted and amorphous, but in which Mr. Hamilton traced every passage from the conglomerate beds of the old red sandstone. He afterwards described the Porphyries of the Island of Lambay as stratified and metamorphic.

Captain Portlock has subsequently, in the Ordnance Memoir of Tyrone and Derry, described these transitions, and proved that granite beds of undoubted sedimentary origin occur in that district.

In the extensive range which the internal composition of these rocks presents; in the one character of a translucent base, fusible into a whitish enamel, interspersed with greenish spots, fusible into a black enamel, found in the slates of Killarney, which Mr. Griffith calls chloritic slates; in the altered limestone of Loughgur; in the shales overlying the Whinsill of Teesdale; in the adjacent lime, in the same locality; in the limestone of Coniston Head, in Cumberland, (which also contains large crystals of felspar;) in the slates near Lefours, on the Meuse; and in the various rocks now described, Mr. Hamilton felt inclined almost to shrink from the universality of the application, and ask the Chemist to investigate the subject more deeply, and to give more refined distinctions, but if he does not come forward to tell us that the lens, and the blowpipe, and the acid have been insufficient to enable us to reason upon the identity of such minute components, he could not but think that composition does not afford a distinction between many of the rocks, hitherto classified as erupted and sedimentary, and that many difficulties may be removed, by our learning to look alone to position, and not to mineral structure.

Thus the position of the Limerick trap rocks appeared to point to their origin in the metamorphism of the impure limestones, shales, and grits immediately succeeding the lower beds of the carboniferous limestone, a series of sufficient variety to produce great variety in the character of the metamorphic rock.

The same idea suggested itself to the mind of Mr. Ainsworth, when looking at the slaty character exhibited to the South of Linfield, but he seems to have withdrawn from its further application, and considered the generality of the Limerick rocks as traps effused; but whether the theory of metamorphism or of volcanic grit, be assumed, as explanatory of the appearances shown in the sections, Mr. H. had no doubt of the sedimentary origin of these rocks.

Mr. Hamilton concluded with the hope that he might not be mistaken as dogmatising upon a subject so obscure, and so little studied. He laid his own impressions before the Society as they were suggested in the field, and would receive as a boon either correction or consent.

The reading of a paper "On the rocks at Bray Head," by Mr. Oldham, was postponed until the succeeding meeting of the Society, the author merely stating the principal results, which were, that the quartz rock, which had been hitherto represented as the principal or predominant rock of the hill, in reality formed only a very minor feature, as to extent; and that the whole belonged to a fossiliferous series, the extension of which from Waterford he had first announced in 1843.

Mr. Griffith stated, that in consequence of the information which he had received from Mr. Oldham, he had caused all this strike of country to be re-examined, and as he might not be present when the paper would be read in detail, he would present the following list of localities in which his observers had traced fossils in this district. He did not agree with Mr. Oldham, as to the relations of the quartz rock with the slates.

Localities of SILURIAN FOSSILS *lately discovered in Waterford, Wexford, and Wicklow.*

County Waterford.—Raheen, on shore two miles south of Passage—Favosites, Encrinites, Orthidæ, and Trilobites, in black clay slate.

Crooke, on shore south of Passage—Encrinites and Terebratulæ, in red and greenish grey clay slate, above the slate of Raheen.

County Wexford.—Duncannon—Orthidæ, in black clay slate at the quay.

Glenwater Bay, north west of Duncannon—Encrinites, Terebratulæ, Orthidæ, and a trace of Trilobites, all very small, and occurring in alternating series of red and greenish grey clay slate, above the black slate of Duncannon.

Nook Bay, north west of Duncannon—Encrinites in black slate, below the red slate of Glenwater Bay.

Tinnaglough, north east of Duncannon—Graptolites in black flaggy slate.

Ballygarvon Bridge, eight miles N. N. east of Duncannon—Trilobites, Orthidœ, and Encrinites, in grey metamorphic stone, part of the black slate series.

Carrigadaggan, south east of New Ross—Favosites, Encrinites, Orthidæ, Orthocerata, and Trilobites, in grey clay slate.

Greenville and Moyne, one mile N. N. west of Enniscorthy—Favosites, Encrinites, Orthidæ, and Trilobites.

Tinnacross, three miles south of Ferns—Orthidæ in grey submetamorphic clay slate.

Ballinatray Bridge, south east of Gorey—Graptolites in black flaggy slate, and Encrinites in black calcareous slate.

Seamount, near Courtown Harbour—Favosites in grey and brownish red limestone, above the Graptolite slate of Ballinatray.

Duffcarrick, on the shore east of Gorey—Favosites, Encrinites, and Orthidæ, in grey clay slate.

Seafield, Ballymoney, and Kildernot, on the shore east of Gorey—Favosites, Encrinites, Orthidæ, Euomphali, Orthocerata, occurring in an alternating series of grey and red slate, with occasional beds of grey and red slaty limestone, nearly in the same position as the red limestone of Seamount, or above the Graptolite slate of Ballinatray.

County Wicklow.—Askintinny, south of Arklow—Graptolites in black flint slate.

Rathdrum Bridge—Favosites, Orthidæ, and Trilobites, on north east side of the river Avonmore, in dark grey slate.

Slieveroe—E.N. east of Rathdrum Bridge—Favosites, Encrinites, Orthidæ, and Trilobites.

June 12th.—Samuel O'Neil Cox, Esq. Hardwicke-street, was elected a member of the Society.

A paper "On the mineral structure of Porphyries," by John Scouler, M.D. F.L.S. was read.

The crystalline rocks may be divided into two classes, or rather parallel series, similar in mineral character, but differing in their origin. The first series includes erupted rocks, which from the evidence of veins, or other circumstances, we know were once in a liquid state; the second series includes traps, porphyries, &c. in every respect identical with the erupted rocks, except that they are believed to be stratified rocks altered by heat. In these metamorphic strata, the same phenomena which appear at the junction of a trap vein with a stratified rock, or of a granite axis, with the adjacent sedimentary masses, are exhibited on a grand scale. There is, however, one interesting peculiarity in the metamorphic series, which constitutes this essential distinction. These rocks although crystalline, and undistinguishable in hand specimens from portions of erupted rocks, have never been in a state of liquidity. The mechanical and sedimentary structure has passed into the crystalline, while the external configuration of the mass remained unaltered; the mechanical structure of the stratum has been changed, its parts have assumed an arrangement indicated by its cleavage planes, and the molecules have grouped themselves in definite proportions, giving rise to crystals, and consequently to porphyries, hornblende-schists, and even amygdaloids. As the metamorphic influence of heat has acted with unequal intensity, we are often able to follow the whole progress of change, from the almost unaltered schist to the crystalline and compact porphyry. At first the argillaceous schist is but little altered, merely rendered more hard and compact, obscure

blotches next appear of various irregular and ill defined forms; and in specimens taken from still nearer the source of heat, these blotches have become angular, and at length pass into well defined crystals of felspar. In such instances, which are by no means unfrequent, we find not only the formation of an alluminous alkaline silicate, but the aggregation of particles diffused throughout the rock, and their final arrangement in a crystalline form.

In the island of Lambay, near Dublin, there is a fine example of a metamaphic porphyry, in which some of these circumstances are very clearly illustrated. This unquestionably stratified porphyry is older than the old red sand-stone to which it appears to be conformable; and its sedimentary origin is proved not only by its position with respect to other rocks, but even in hand specimens traces of mechanical structure may often be discerned. The felspar crystals diffused throughout the schistose paste, are often of considerable magnitude; and one of the most interesting circumstances connected with their history, is the fact, that when broken across, they often contain an earthy nucleus, precisely analagous to what we observe in andalusite, and which has obtained for that mineral the name of hollow spar. In the present instance, therefore, we have evidence of the aggregation of the mineral matter diffused throughout the mass of schist, and also, that as in the case of many concretions, a foreign body has acted as a centre of attraction.

In the case of conglomerates, which have been influenced by heat, we have a still more conclusive evidence of this combined mechanical and chemical action, which can take place even in the most solid rocks. There is near Tramore, in the County of Waterford, a conglomerate of the old red sand-stone, which has been traversed in several places by trap dykes, where in contact with the trap vein, the pebbles of the conglomerate have undergone a remarkable change, so that a hand specimen might be mistaken for a fragment of globular porphyry. The pebbles have become rounded, their internal structure is changed, and they are no longer masses of homogeneous quartz, but are composed of alternating coatings of quartz and felspar, so that the spheroids call to mind those of the orbicular granite of Corsica.

In the two instances here mentioned, there can be little doubt as to the history of the change, however deficient we may be in possessing a complete theory of the process. There appears to be no doubt that a series of mechanical and chemical changes take place, while the rock, which is the seat of them, remains in a solid state, and that in respect of their mode of formation—these metamorphic rocks have acquired their crystalline forms and characters by a process somewhat different from that which operates in molten rocks in producing similar structures.

A paper "On the rocks at Bray Head," by T. Oldham, M,R.I.A. F.G.S. Curator of the Society, was read.

The author commenced by directing attention to the views of the writers who had previously examined and described this district, by all of whom the quartz rock was considered the predominant rock; by several it was described as unstratified, and unassociated with the slates; which by all had been viewed a sprimary, or belonging to a distinctly non-fossiliferous series. Mr. Oldham shewed that some cuttings recently made, had exposed the slate rocks where they had not previously been visible, and from this, it was rendered evident, that the quartz rock had no greater extent than what was actually visible; its hardness and indestructibility causing it to remain prominent, while the softer slates which adjoined it have been decomposed. The projecting hummocks, therefore, which gave the peculiar rugged outline to the hill, were the only parts which should be referred to as quartz rock, while all the slopes covered with vegetation were composed of the slates; and thus the quartzite, instead of being the predominant rock of the hill, really formed not one-fourth of the surface, and was only a minor and subordinate member of the general series. It was also shewn that it both rested on, and was capped by the slates in more than one place, and it was therefore argued that it was interstratified with them. That it was of mechanical origin was evident, from the occurrence of numerous rounded pebbles of quartz throughout the general mass of the rock, which is a semigranular, semivitrified quartz, composed of small grains, which are run together without any cement.

The author states that he had not as yet been successful in finding organic remains in the slate rocks of Bray Head, with the exception of some small zoophytic markings, which did not appear referrible to known genera. At the meeting of the British Association in Cork, (August, 1843) he had mentioned that the silurian slates of Waterford, instead of forming a small and isolated patch, as shewn on Mr. Griffith's map, really were a portion of a very extended region, which passed with a tolerably regular strike across the estuary of the Suir, into the County of Wexford. He was also aware of the occurrence of fossils, further north in the County of Wicklow; but not sufficiently acquainted with the details to enable him to state the fact clearly. He had since traced them in the neighbourhood of Rathdrum, in Wicklow, where it appeared they had also been found by Mr. Griffith; and still further north than Mr. Griffith had observed them, near the village of Newtown-Mount-Kennedy; and he did not hesitate to state his conviction, that the fossiliferous series was continuous from Waterford to the immediate vicinity of Dublin; and he believed, that should sub-divisions of these slates be hereafter considered advisable, the great

prevalence of siliceous deposits, which marked, as it were, a zone in the series, might form a guide in the classification.

Mr. Griffith had, at the previous meeting of the Society, exhibited a section, to shew that the quartz rock of this district was not interstratified with the slates, but was one great mass intruded among them, and on which they rested unconformably. Mr. Oldham stated that he had revisited the locality referred to, and was still of the same opinion. He thought the relation of the two kinds of rock were in this particular place too confused to prove any thing positively on either side of the question; and he was persuaded that Mr. Griffith's section not being made in the line of dip, was calculated to give an erroneous idea of the facts. He also stated that the slate rocks which appeared near Balbriggan, to the north of Dublin, were fossiliferous.

The surface of these rocks at Bray Head were found to be perfectly polished, the edges of the harder beds rounded off, and all scratched and furrowed by a series of parallel groovings or markings. The direction of these was from 23° E. of north, to 23° W. of south. They were nearly parallel to the face of the seaward cliffs of the hill, and not in the direction of the slope of the ground, and were but very slightly inclined. They were between five hundred and six hundred feet above the present sea level. Markings of a similar character were seen on the granite at Killiney, and had been noticed in abundance by Mr. Mallet, on the limestone exposed by the cuttings of the Dublin and Drogheda Railway.

The President stated that he had recently examined the hill of Carrickmacreilly, near Glanely, in the County of Wicklow, which had hitherto been represented as one mass of quartz rock, and had found that it really consisted of two distinct stratiform masses, whose relation to the accompanying slates was precisely as Mr. Oldham had described in the similar rocks at Bray Head. The same relations could also be traced northwards to near Newcastle.

A paper "On the more recent Geological deposits in Ireland, by T. Oldham, M.R.I.A. F.G.S. was read.

Mr. Oldham commenced by remarking on the peculiar features in the physical outlines of the country, resulting from the great prevalence and extent of the gravel and clay deposits in Ireland, forming in some cases the long, low, and rounded ridges, which cross the central plains, so generally known as Eskars; in others, the islands or derries, which break the monotonous surface of the bogs; and again, the undulating grassy plains. He then proceeded to notice the observations of previous observers, quoting Mr. Weaver, Dr. Lloyd, and Mr. Bryce. Mr. Griffith, in his presidential address to the Geological Society of Dublin, in 1836, in commenting on a paper by Captain Portlock, "On deposits of shelly gravel underlying

Dundalk," gave a succinct account of his views regarding the relative age of the several deposits of clay, marl, and gravel in Ireland. At the meeting of the British Association, held previously in Dublin, Mr. Griffith had noticed a deposit of gravel, containing shells and clays, in the County of Wexford, covering a space of one hundred square miles. This deposit has since been traced to a much greater extent, by Captain James, R.E. Mr. Griffith announced that the shells from this deposit had not been sufficiently examined at that time, to enable any thing to be said regarding them with certainty; but that some were not identical with recent species; and that it was possible this deposit might be referred to the age of the Crag of Norfolk. Parts of this deposit were stated to be seventy feet above the sea. In these remarks, Mr. Griffith states, that he "has never observed any traces of shells in the Eskars, even where at Wesport they occur, forming islands in the Atlantic:" and remarks on the importance of this character, as distinguishing these deposits from those evidently deposited on an ancient strand or sea beach, and from lacustrine deposits. He gives it as his opinion, that the eskar gravel deposit is the oldest or first, next, the system of boulders now observed on the surface, and which consist of various rocks. These are probably more ancient than the elevated beaches, and other deposits which contain shells. Of the latter class, that at Wexford was considered the oldest then noticed in Ireland. Next in order were placed, the marine depositions of the coast, while the fresh water shell-marl and lacustrine deposits were considered as "the most recent, and as due to causes which are probably still in operation at the bottom of our great lakes and sluggish rivers." (Jour. Geol. Soc. Dub. Vol. 1, Part 3.) Captain Portlock subsequently noticed (1838) the occurrence of marine shells of recent species, one hundred to two hundred feet above the level of the sea, in the County of Sligo; and Dr. Scouler described, with his usual accuracy, some deposits of gravel and clay in the vicinity of Dublin, which contained marine shells. Mr. Weaver had previously mentioned these deposits, but was not aware of the occurrence of shells in them. Dr. Scouler noticed the fact of shells being found at Howth, Bray, and Glenismaule, at a considerable elevation above the sea; and remarked on the occurrence of similar deposits in other places, but which did not contain shells. He arrived at the conclusion, that the coast around the Bay of Dublin, has been elevated at a comparatively recent Geological epoch; and that the amount of this elevation has varied at different places. He thought this elevation had been *gradual* and unequal in amount, the shells being found at heights varying from eighty to more than one hundred and fifty feet above the level of the sea. Mr. Oldham remarked that however correct this conclusion of Dr. Scouler might be—that the elevation had been *unequal in amount* in the various places—he could not admit that the evidence on which it was founded was sufficient.

There were *many* other co-existing circumstances to be proved before the mere fact of the present occurrence of shells at different heights could be considered adequate proof, that the cause which had elevated those shells to their present position, had acted with unequal effect in the different places. About the same time, (Jour. Geol. Soc. Dub. Vol. 1. Part .) Mr. Trimmer announced the important discovery of fragments of the Irish hardened chalk in Wales, at elevations ranging even to one thousand feet above the level of the sea; and here also associated with shells, as near Dublin. About the same time, Mr. Griffith published his "Outline of the Geology of Ireland," in the second report of the Railway Commissioners, in which he briefly notices these deposits, stating the course in which the currents forming them appear to have moved in many instances; and says, "it is remarkable that no marine or terrestrial shells have hitherto been discovered in the gravel of the Eskars." And under the head of "Tertiary deposits," Mr. Griffith repeats the observation he had made some years previously, "that the apparently elevated gravel deposits of Wexford, had not been sufficiently examined to determine whether they should be classed among the tertiary formations, and consequently they were not included in that series." In 1840, Mr. C. W. Hamilton brought under the notice of the Society, the disposition of the materials in some gravel pits in Kilkenny, with a view of showing that this arrangement afforded evidence of successive deposition from water, and could not be explained on the glacier theory, then warmly supported; and again, in the same year, submitted some drawings, and described the polished rounded and furrowed rocks, which he had noticed in the west of Kerry, and on the Keeper mountain in Tipperary. Dr. Scouler, in commenting on this paper, and one by himself, on the proofs of elevation observed in Lanarkshire, near the falls of the Clyde, admitted that the action of glaciers was a "*vera causa*," solving many difficulties which would otherwise be insuperable; and reasoning on the necessary results of admitting this, viz. that we must also admit such a change of climate as would allow of ice accumulating both at smaller elevations and at lower latitudes than at present, in those districts where moraines occur; he pointed out the evidence we have of change, in the relative distribution of land and sea in this hemisphere, and argued that these alterations would involve very great changes in the isothermal lines, as well as in all those circumstances which constitute the difference between an equable and an extreme climate.

But even granting that such a submersion of the land were to take place, it yet appeared to Mr. Oldham only an assumption to suppose, that the effect would be such a change in the climate—and this, too, a widely extended and general change—as would be sufficient to account for the occurrence of glaciers. Besides, another, and, as it appeared to him, a very great difficulty as regarded this

supposition arose from the consideration of the fact, that even allowing that the refrigerating effect would be sufficiently great, still to account for these glacier scratches on this supposition, it would be necessary to suppose that the glaciers had moved along the bed of the ocean, at a considerable depth; for many of the localities where "roches moutonnes" are now seen, would then, granting the supposition, have been even some hundred feet under the level of the sea.

At the close of last year, Mr. Wilkinson presented to the Society, specimens of wood found in a bed of black peaty clay, at a considerable depth, in sinking a well at Nenagh. This peaty clay was covered by forty-three feet of hard calcareous clay, with numerous large rounded lumps of limestone intermixed, but unstratified. Dr. Scouler, in noticing this communication, in his annual address as President, (1844) regarded it, in connexion with other observations, as evidence of elevation. He at the same time mentioned his having obtained the rib of a whale from the marl beds of Wexford; and while stating the absence of marine shells in the Eskars, shewed that the stratification, or sorted arrangement of the materials, sufficiently proved that these gravel beds had been deposited "in shallow but turbulent waters, little favourable for the abode of molluscous animals." In Captain Portlock's Geological Report on Londonderry, &c. is a full account of extensive deposits of coarse calcareous clay, containing marine shells, and which was found at various elevations above the sea, ranging to more than three hundred feet, and extending inland, from the present sea shore, for about fifteen miles—the shells found were Turritella terebra, Cyprina islandica, and Nucula oblonga. From the presence of the latter shell, Captain Portlock considered that these deposits should be referred to the newer Pliocene period. To this Report Mr. Bryce and Mr. Hyndman jointly contributed a short description of a similar deposit of clay, cut through in forming the water works at Belfast. The surface of this deposit was one hundred and six feet above the sea. It produced a considerable number of species, including a mixture of both littoral and deep water shells; but characterized by the extinct Nucula oblonga, and by the Astarte gairensis, also so frequent in the similar deposits on the banks of the Clyde.

Mr. Smyth of Jordan Hill, to whom our knowledge of these recent deposits is so much indebted, had previously noticed the occurrence of a small patch of sand containing a very great variety of shells, all, however, similar to those at present existing, at Portrush, raised above the level of high water at present, about ten feet.

In August, 1843, at the meeting of the British Association, in Cork, Mr. Griffith gave a brief notice of the occurrence of marine shells of recent species on Tarmon Hill, two hundred and fifty feet above the present sea level, on the coast of the Atlantic, in the County of Mayo.

"Such is nearly the entire amount of our knowledge with regard to

the so called diluvial deposits of our island; and it must be confessed it bears a very trifling proportion to the importance and extent of these formations. It may have been noticed, that with respect to none, excepting those described and mapped by Captain Portlock, do we possess any accurate data, either as regards their elevation above the present sea level, or their superficial area; and also, that although shells have been found in several places in these clays, none of the deposits, excepting those in Derry, and near Belfast, have been determined to belong to any period previously to the present existing race of animals; but have been looked on as "raised beaches," &c. And a reference to the Geological Map will shew that none of these have been considered of sufficient importance to be represented, excepting that of the lignite clays, near Lough Neagh—a deposit of an age previous to that of those we are now describing."

Mr. Oldham stated that he had been much struck with the very marked similarity in general character and arrangement of the clays near Dublin, and those with which he had become acquainted, while engaged under Captain Portlock, in the examination of the County of Londonderry; and he had, therefore, examined them as opportunity afforded. He had thus traced them in several places where they were not previously noticed as existing; and had also observed shells in several localities. He stated that "this calcareous deposit of clay, gravel, and sand, irregularly mixed and alternated, may be traced (south of Dublin) at Killiney Hill, on the telegraph or quarry summit of which, is a thin deposit of calcareous gravel: on the south side of the hill it is of considerable thickness, and abounds in shells; gradually dropping down from its highest point, (here upwards of four hundred feet) it forms low bluffs, varying from ten to sixty feet in height along the shore to Bray, extending inland to Cabinteely; up the valley of the Loughlinstown river, to near Ballycorus; near Kiltiernan and Kilgobbin; south of the Scalp, of great thickness in the valley of Glencullen occasionally, and in local patches of small extent in Glencree; of considerable thickness along the Dargle river, between the Waterfall and the Dargle, flanking the north-west side of the greater Sugarloaf, where it rises to the highest elevation, at which I have traced the occurrence of shells, upwards of six hundred feet above the level of the sea. Along the Bray river, between the Dargle and the sea, it forms low precipices, and in parts exhibits a good section, shewing the alternation and irregular development of gravel and clays in the deposit. Stretching round the southern point of the mouth of the Bray river, under the Martello Tower, it extends from this to Bray Head, the northern slopes of which, including Kilruddery, are formed of it. And here I would remark that the richness and fertility of this magnificent amphitheatre, so contrary to what might naturally be expected from soils derived from an eminently siliceous district, are almost entirely due to the presence of this thick covering of calcareous clays and gravel.

"Rounding Bray Head, we again find these deposits as described by Dr. Scouler, and extending from this, in a great but interrupted plain, to Wicklow, filling the glen between the two Sugarloaf hills, &c. South of Wicklow Head, the same clays and gravel, still containing marine shells, may be traced in most parts of the low country, and exercise such a powerful influence on the agricultural produce of the soil, that the outline of these deposits forms a tolerably accurate index to the value of the land. Still further south, the valley of the Slaney, above and below Enniscorthy, cuts through similar limestone clays, and the limestone masses they contain, are here of much value, being burned into lime for agricultural purposes; while still nearer to Wexford these deposits of sand, containing an abundance of marine shells, extend over more than a hundred square miles, and are found at elevations of two hundred and fifty feet above the present sea level; but in these, Captain James who examined them with some care, found *none* but shells of the same species as those at present existing on our shores.

"North of Dublin, the same clays and gravel have been cut through, in the line of the Dublin and Drogheda Railway, near Raheny, and between this and Malahide. At Howth they have already been noticed by Dr. Scouler; along the shore at Dollymount they form low bluffs; more inland, they are found at Swords, one hundred and fifty feet above the sea; a thick covering of them rests on the limestone at Finglass, where fragments of shells can be picked up in some numbers, and here, upwards of two hundred feet above the sea; they stretch up the Liffey along the Phœnix Park. Further west, near Lucan and Leixlip, they may also be traced, and here, the distinct eskars commence; near Clane, about twenty miles inland, marine shells in fragments are found in the gravel; from a gravel pit near to Naas, and about three hundred and eighty feet above the sea, I have obtained broken shells; between Athy and Castlecomer, on the flanks of the elevated coal field, along the valley of the Barrow, by Carlow into Kilkenny, close to the town of Roscrea in Tipperary, and here, in a distinct eskar, at a height of four hundred feet above the sea, and I may say in the very centre of the island.

"Near Drogheda, at Dundalk and at Carlingford, as noticed by Captain Portlock and by Major Patrickson; but it should be stated, in these cases at very small elevations, similar deposits containing marine shells are found. If to these cases we add that at Belfast, described by Mr. Bryce and Mr. Hyndman, those in Derry by Captain Portlock, that in Mayo by Mr. Griffith, and unite with these evidences the occurrence, as I had occasion to notice last year, of small pebbles of the hardened chalk of Antrim, so peculiarly characteristic of these deposits; and of flint in the gravel of the County of Waterford, and at Clonmel and Nenagh in Tipperary, (although shells were not seen in either of these places) it will, I think, be evident that the cause, be it what it may, which gave rise to these

deposits, has been *no local one;* has not been confined to any limited area; but has affected the island at large: and that these deposits cannot, without doing violence to the facts, be viewed any longer as merely littoral deposits, or as 'raised beaches.' That they are raised is obvious; but that they are, or ever were beaches, is very questionable.

"In this list of localities, where I have myself had the opportunity of seeing shells in those gravel deposits, or where they have been observed by others, I have for the present included all under the same head; not that I believe them all to be contemporaneous deposits, but in order to give at a glance, the most general and comprehensive view of the amount of evidence which they afford, as to the change of relative level of land and sea in these more recent Geological epochs; and while speaking on this subject, I would wish to guard against an error, which appears to me to be frequently overlooked—the error of forgetting that when we speak of elevation and depression, we use terms expressive of ideas of *relation*, and unless we can satisfactorily establish their co-relative term, our language is worse than meaningless. If elevation takes place, it must be elevation *above some fixed line or level;* if depression, it must be depression *below some fixed line.* In ordinary description, from the very general and almost universal habit of referring elevations to the sea level, it does not become necessary to state our datum line; but the case is very different when we are reasoning as to things of former times, where we have to establish that datum, as well as the relative position of objects vertically, with reference to it.

"Without entering on the reasons for doing so, I shall for the present, consider the sea level, as at least the more constant datum, and refer to it when speaking of former elevations. But even granting this level to be constant, and granting also that the evidence presented to us may be sufficient to determine with tolerable accuracy the line of that level, it must still be borne in mind that deposits are now taking place, and at all times must have taken place, at different depths beneath that level; and the mere fact of their present occurrence above that level at different heights, does not at all prove that they have been elevated through different distances. Suppose, for instance, that the deposits now forming at the bottom of the sea—say on our own shore—at the depths of two fathoms, and of thirty fathoms, were all brought to light by an upward movement of the land of about two hundred feet, it is evident that although quite contemporaneous, and although the elevation had been perfectly equal in amount in all parts of the area moved, still these deposits would now be found at elevations of twenty feet, and one hundred and eighty-eight feet above the level of the sea; and any conclusion drawn from this fact, as to the unequal amount of the upward motion, would be obviously incorrect. Similarly, before we can admit a difference of present height above the sea, as a proof of inequality

in amount of elevation, it must be shewn not only that the deposits were perfectly cotemporaneous, but also, that if cotemporaneous they were originally formed at the same depths in the then sea. Other and minor causes affecting the conclusion must also be attended to.

"With these difficulties, therefore, it will always be a problem requiring the most cautious exercise of reasoning to argue from such observed phenomena back to their causes. If, from the more accurate means of observation which the advance of science places at our disposal, we can establish any law as to the present movements of our island, we can then reason back, and comparing the results obtained from calculation, with those derived from observation, we may obtain such a confirmation of the former as may place their probability beyond a question.

"I shall not, therefore, attempt, from our present very imperfect data, to draw any conclusion which I would wish to place before the Society with even a pretension to accuracy. If, however, it may be allowed to throw out a speculation, and taking all the observations in Ireland, with their relative elevations above the sea, and coupling with them those in North Wales and in the West of England, (for in all such reasonings the undue importance which from early habit we are wont to give to the separating channel must be laid aside, and it must be considered, as it really is, merely as a trifling valley between the hills on either shore,) taking, I say, all in connexion, there would seem to be some probability that this upward movement or movements have taken place with reference to a certain axis or line, and, just the contrary to what is supposed with reference to England, and of what was too hastily concluded with respect to Ireland, that this motion has affected the eastern coast more than the western. This is, however, merely a speculation.

"It is difficult to realize fully to the mind the effect which would result from such a change of level as regards the distribution of land and sea. If these deposits, which I have shewn to contain marine shells, be admitted as valid evidence that the parts of the island where they occur were covered by the waters of the sea, at the time of their deposition, and if their occurrence in so many places be taken as a proof that this covering of the ocean was not local, but general, it immediately follows that our island was at that time not one large island, but a cluster of small ones in an archipelago. The highest level of either of the canals which cross the centre of our island, is 310 feet above the sea, while I have shewn that these marine shells are found in the centre of our island at 400 feet, and near this city at 600 feet and more, above the same level. I have said that I have not as yet found shells at a greater elevation than a little more than 600 feet, but from other indications, I suspect that the same deposit reaches an elevation in some places of 1000 feet. Taking this, therefore, as the extreme, and supposing the same amount of difference to affect the whole island, Ireland would then

be almost annihilated, or only represented by a few scattered islands in an extensive ocean, chiefly confined to the present coast of our land. This, however, is an extreme case, and if we take a better average, and suppose the difference to amount to only 500 feet, the land then visible would form two clusters of islands in the north and south of the present island, divided by an extensive ocean passing across the centre." Mr. Oldham exhibited two maps shewing the results, and proceeded :—

"Hitherto I have grouped all these instances into one general class, hinting, however, that I did not believe them all to be cotemporaneous, and I have now to announce an important observation, viz. the discovery of extinct shells in some of these deposits. To those who have paid attention to these recent formations, it is well known that the newer pliocene deposits of the Isle of Man, of the Clyde, of Cheshire, &c. are characterized by the presence of a delicate nucula—the Nucula oblonga. This shell was found in the clays of Derry, and at Belfast, and there are here specimens from the similar clay at Killiney, obtained about 180 feet above the sea. I have also specimens from Bray, and from the flank of the Sugarloaf. With this shell, in the Clyde deposits, is a very beautiful Astarte—the Astarte Gairensis; this was also found at Belfast, and I have placed on the table a specimen from Killiney; previously to finding this more perfect specimen, I had found one or two fragments, and I am indebted to the kindness of Mr. James Bryce for forwarding to me a valve from the Belfast deposit for comparison. These are, therefore, sufficient, I think, in connexion with the similarity in general character, to prove that these deposits, though so widely separated, must be referred to the same general epoch—the newer Pliocene or Pleistocene.

"Dr. Scouler gave a list of eight species observed by him in these deposits at Howth and at Bray, as follows :—

Turritella terebra, one of the most common,
Turbo littoreus,
Nerita littoralis,
Buccinum undatum,
Cardium edule,
Cyprina islandica,
Pecten varius,
Dentalium entalis.

"To this list I am able to add :—

Ostrea edulis, Killiney & Bray,
Tellina solida, not uncommon,
Pecten opercularis, Killiney,
Pullastra decussata, Do. & Bray,
Nucula oblonga, Killiney, Bray, and Sugarloaf,
Astarte Gairensis, do. do.
Corbula nucleus ?
Saxicava rugosa, rare.*

"It is obvious, from the extremely imperfect examination which these deposits have as yet received, that it would be impossible to apply to them any reasoning from a per-centage of recent and extinct shells, but from the presence of the very characteristic shells, the

* This was found by Mr. Lyell to be the most common and prevalent shell in the American and Swedish deposits, of the same age as those I am speaking of.

Nucula and the Astarte, I would refer them to the same age as the other similar deposits in which these occur. I believe, therefore, that as far as regards these clays and gravels near Dublin, at Killiney, at Bray, at Sugarloaf, and at Finglas, where also I have procured fragments of the same shells, that it will be acknowledged that they must be referred to the most recent of the tertiary period. And this we may conclude is also the case with the marl of the south of Wicklow and Wexford. But here a question of great importance arises—are these cotemporary with the eskar deposits? As far as I know at present, I believe they are. The clays and gravel in which they occur are identical in composition, in ingredients, in the travelled rocks which they contain, with the patches of clay and clayey gravel which are common in the undoubted eskars. The shells I have hitherto found do not prove this, but they do not prove any thing to the contrary; their mode of occurrence, generally in fragments, and indiscriminately mixed up with the clay and gravel, is identical with their mode of occurrence in those deposits undoubtedly of this age, and all the probabilities appear to lean to this view. It is, however, a point on which I am most anxiously looking for further evidence, and I believe I need not impress on the Members the importance of the enquiry—can we satisfactorily establish this, the enormous difference it would make in the colouring of our Geological Map will in itself be sufficient proof of its importance. And I would venture to solicit aid in accomplishing this. It needs no previous acquaintance with Geological examination, it requires no great expenditure of time or trouble, nor any very accurate observation, to look for and procure, if possible, fragments of shells from a gravel or clay pit. I have never yet failed to find fragments, at least, of shells, wherever I found clays, hard, close, blueish, gravelly clays with the gravel, and in these I would look with something amounting almost to a certainty of success. It needs only to notice the locality carefully, so that it may be entered on the map, and to bring away what specimens may be found, if any. They are occasionally found so friable as not to bear carriage, but in this case even the knowledge that they really occur is a very important addition to our information.

"Such is the evidence derived from the remains of molluscous animals, with regard to these deposits, and it is almost the only evidence we can bring. The bones of the elk (Cervus Megaceros) found near Enniskerry, are by no means satisfactorily proved to have been found in the gravels, and we have, therefore, only the elephant's teeth, described by Molyneaux, as found near Belturbet, the rib of a whale from Wexford, noticed by Dr. Scouler, another from Waterford, noticed by Smith in his history of that county, and the tooth of a hippopotamus from Carrickfergus, as mentioned by Captain Portlock.

"I spoke before of the relative change in level of land and sea,

which must have taken place to have brought these shells to their present position. But we have no reason to suppose that this motion has ceased. On the contrary, every thing would shew that it still continues, or has continued to a very recent period. I have already quoted the occurrence of shells ten, eighteen, and twenty feet above present high water in several places; and we may add one or two more instances, probably even more recent. In raising brick clay at Portmarnock, near Howth, shells of the same kind as those now on the shore—Tellina solida, Cardium edule, &c. were found but a few feet above the level of high water, and for the knowledge of this fact I am indebted to my friend, Dr. Farran. And in the new cuttings for the river Liffey, opposite the Royal Barracks, our excellent Secretary, Mr. Ball, observed (an observation made almost simultaneously by myself) Tellina solida, Amphidesma compressa, and Cardium edule, considerably under high water mark certainly, but these creatures are not now found higher up the river than probably the end of the North Wall, more than two miles lower down.

"To determine the amount and direction of any movements which may be taking place, is a problem of great scientific interest, as well as practical importance, and for this purpose the recent levelling operations performed by the Ordnance Surveyors, will afford peculiar facilities."

Mr. Oldham did not enter upon any enquiry as to the cause which distributed these gravels, clays, and large boulders, over the surface of the island. He did not think the subject yet ripe for reasoning. The general and prevailing movement of the materials is abundantly proved to have been from the north and north by west, by the rocks found in the gravel which must have come from that quarter; but it is obvious that whatever the translating power, whether moving water, or floating ice, it must have been subject to many disturbing actions, from contact with shoals or with islands. He thought that here the important question of how much might be asked with justice; that from the data supplied by the Ordnance Survey, it would be possible to chart the ancient sea-bed, to map its shoals, and trace its sand banks, and that doing so, it might be possible to account for the apparently contradictory courses which some of these gravel deposits seem to have taken. In this undertaking, Mr. Oldham was engaged, and he solicited aid from others. The first point was to map the eskars with tolerable care, and this might readily be done by any one, though scattered as they were over so wide an extent of country, it would be impossible for any individual to accomplish it within a reasonable time. His object in thus bringing the matter forward in a crude state, was to excite attention to the subject, and thus to procure, if possible, additional information.

ERRATUM.—Page 59, line 9, *for* metamaphic *read* metamorphic.

JOURNAL

OF THE

GEOLOGICAL SOCIETY OF DUBLIN.

VOL. III. PART I. 1844. No. 4.

November 13th—The Most Noble the Marquis of Downshire, Hillsborough; Samuel O'Neill Cox, Esq. Hardwicke-street; S. Jones, Esq. C.E. Clonmel; John Ross Mahon, Esq. Stephen's Green; M. B. Mullins, Esq. Fitzwilliam-Square; Arthur Todd, Esq. Kildare-street, were admitted Members of the Society.

Notice of "Observations on the Temperature of Mines in Ireland," by Thomas Oldham, F.G.S. &c. was read:—

Some years back Captain Portlock, R.E., was requested by the British Association for the Advancement of Science, to conduct a series of observations on the temperature of mines in Ireland. Continued occupation having prevented his attention from being directed to the matter, the instruments furnished by the Association, passed into Mr. Oldham's charge, and permission being obtained from the Mining Company of Ireland, they were fixed in the deepest part of the workings in their Copper Mines at Bonmahon, in the Co. of Waterford. By the zealous and very effective assistance of Mr. Petherick, the Mining agent of the Company, every facility was afforded for having them properly registered, and by the aid of the Mining Captains, a series of continuous readings was obtained, for the most part on each alternate day, during a space of eleven months. The Thermometers were fixed in August, 1843, one being placed in a hole bored three feet into the solid rock, or "country," as miners call it, and one sunk to the same depth in the lode; a third was hung at the same depth below the surface, freely in the air of the gallery; while a fourth was suspended at a height of about four feet above the surface, protected from radiation as far as possible. Prior to fixing the instruments they had all been carefully compared with the standard thermometer, used by the Rev. Dr. Lloyd in the Magnetic Observatory of Trinity College, and their index errors ascertained.

The instruments under ground were placed at a depth of seven hundred and seventy four feet below the surface, and the general average results were as follows:—The average of the entire number of observations of the thermometer placed in the lode gave 57.915 Faht.; of the thermometer in the rock or "country," 57.°369; and of that in the air of the Mine at the same depth, 57.176. The difference on the general average of eleven months between the air and the rock at the same depth was that the rock was 0.193, or nearly two tenths of a degree higher. The difference between the average temperature of the rock and the lode, at the same depth, was that the lode was 0.546, or more than one half a degree higher.

If now we take the general average of all the observations of the temperature in the rock as the datum, (it being nearly a mean of the temperatures of the lode and of the air at the same depth,) and compare this with the mean annual temperature at the surface, the results will be these—Calculating the mean annual temperature by the ordinary formula, $t = 81°.5$ *cosl.* the latitude of the mines being about 53°8'30", the mean temperature would be 50°.026. This gives therefore, an increase of 7°343 for seven hundred and seventy four feet. Deducting from this, one hundred feet, in order to arrive at the line of no variation, we have 7°343 Faht. for 674 feet, or 1° for 91.82 feet; a much slower rate of increase than has been hitherto noticed.

If, however, from the peculiar position in which it was found necessary to place the instruments in the present case (not more than forty feet from being perpendicularly under the sea,) we consider the sea level as the surface, and deduct the difference between this and the surface of the ground, we have the depth, from line of no variation equal to 600 feet, and calculating the increase in temperature of 7°343 for this depth it gives a ratio of 1° for 81.74 feet; this, even after all deduction being made, is a much slower rate of increase than has been usually observed.

The author noticed also the fact of a gradual decrease of temperature indicated by all the instruments under ground; thus the average of the first half of the series of observations of the thermometer in air at the bottom, from August to January, gave 57°613, and from January to July only 56.697, being a diminution of .916 or nearly one degree; the thermometer in the rock shewed a similar diminu- of .674. That this diminution was a gradually increasing one, would be evident from comparing the results more in detail, but the general fact would appear established, that so far from the operations of mining, the men employed, blasting, &c. having a tendency to increase the temperature below, this temperature constantly dimi-

nished, while the number of persons employed in that part of the mine increased.

Mr. Oldham also described the general features of the Mines, the mode of occurrence of the ore, &c., and noticed the almost total absence of crystallization in the metallic deposits, with other peculiarities.

December 11th—C. H. Domvile, Esq. 13th Light Dragoons, was admitted a Member of the Society.

A notice, "On some timber found at a considerable depth below the surface, in the Co. of Tyrone," by Wm. Murray, Esq. M.R.I.A. was read.

Mr. Murray presented a portion of fossil wood, part of a large tree, found at the depth of 57½ feet, in sinking a well in the demesne of Roxburgh, the seat of the Earl of Charlemont, Co. Tyrone.

The well is situated on the side of a hill, about one hundred perches from the margin of the river Blackwater. The ground between the river and the base of the hill is flat and nearly level, and is almost constantly covered with water during the winter months. The beds were as follows from the surface:—

16	feet	through	strong sandy loam,
16	„	„	strong red clay,
12	„	„	white pipe or potters' clay,
4	„	„	light coloured fine sand,
9½	„	„	yellow clay.
57½ feet.			

The tree was found imbedded in the yellow clay, surrounded by decayed leaves or bark, and very black. The roots, which lay in the same position as the trunk, were impregnated with iron pyrites, in small crystals. The sinking of the well was continued for eighteen feet below the bed of the tree through the same yellow clay, before the spring was discovered. On arriving at a bed of dark gravel, the water burst up with such force, that the workmen were obliged to make a precipitate retreat.

It would appear from the circumstance of the tree and the roots lying in the same position, that it had grown on the spot where it was found, and had not been carried by floods from any other situation.

Mr. Murray supposed the wood to be yew or sallow, but a closer examination shewed it to be distinctly coniferous.

The same stratification generally prevails along the banks of the Blackwater, reaching as far down as Lough Neagh, and the tree, &c. appears to be only a part of the similar deposits of lignite in that district.

"On a new Zeolitic Mineral," by Dr. Apjohn, M.R.I.A. Professor of Chemistry, Royal College of Surgeons, &c.

Having some time since received from a friend a zeolitic mineral, found at Newtown Crumlin, near the village of Clough, in the Co. of Antrim, which appeared to me to be new, I had it analyzed in my laboratory; and as the results would seem to separate it from all known species, I may probably be permitted to communicate a short notice respecting it to the Geological Society. This mineral occurs in masses of an ochre red colour, composed of numerous small nodules, which when broken across exhibit a radiated crystalline structure. The specific gravity is 2.229, and heated upon platinum wire before the blowpipe, it melts without effervescence upon the surface, but does not run into a globule. Under the influence of the heat its red colour disappears, and it becomes nearly white. I may here observe, that the per-oxide of iron, which is the cause of the colour of the mineral, is merely mixed, not chemically combined. This conclusion I draw from the fact of some parts of the mineral being destitute of colour, and from the circumstance, that after its gelatinization by acids, the per-oxide remains for some time undissolved. The following are the results of a very carefully conducted analysis of this mineral made for me by Surgeon Head, the gentleman to whom I am indebted for the specimen.

Silex, ...	39.236
Alumina, ...	28.650
Lime, ...	12.535
Soda, ...	4.693
Per-oxide Iron, ...	1.140
Water, ...	13.632
Loss, ...	0.114
	100.

These numbers correspond perfectly to the following formula:—

$$Na\,O,\ Si\,O_3 + 3\,(Ca\,O,\ Si\,O_3) + 2\,(2\,Al_2\,O_3,\ Si\,O_3) + 11\,HO.$$

The mineral, therefore, is obviously a kind of mesolite, differing however from the well known mineral of that name, in containing not a silicate, but a di-silicate of alumina. This will probably be more distinctly seen by resolving the formula into the following, viz.

$$\overline{Na\,O, Si\,O_3 + 2\,Al_2\,O_3, Si\,O_3, + 2\,H\,O} + \overline{3\,(Ca\,O,\ Si\,O_3) + 2\,Al_2\,O_3 + 9\,H\,O}$$

the first of which represents a *Natrolite*, and the second a *Scolezite*, not yet described, but the discovery of which on some future occasion may be fairly anticipated.

I may here observe, that although this mineral was new to me, it was not so to our Curator, Mr. Oldham, for having shewn it to him while it was under analysis, he recognised it at once as an old acquaintance, and was good enough to furnish me with a specimen from his collection. This specimen, which I may observe, exhibits all the physical characters of the mineral just described, save its red colour, has been also analyzed in my laboratory, and I submit the results for the information of the Society.

Silex, ...	39.606
Alumina, ...	28.215
Lime, ...	11.728
Magnesia, ...	1.053
Soda, ...	4.948
Water, ...	14.392
Loss, ...	0.058
	100.

The constitution of both specimens is therefore clearly the same, and is represented by the formula

$$Na\,O,\,Si\,O_3 + 3\,(Ca\,O,\,Si\,O_3) + 2\,(2\,Al_2\,O_3,\,Si\,O_3) + 11\,H\,O.$$

already given.

From the above analogy, as respects composition, between this mineral and *Mesolite,* I venture to suggest that it be called *Mesolitine.* The term Mesole or Mesoline, would be more simple, but these have been already appropriated to Zeolites of a somewhat kindred constitution. There is no danger that Mesolitine will be confounded with Mesoline, but while very distinct from, there can be no doubt that it approaches closely in composition to Mesole, as may be seen by the following formula, deduced from the analysis made by Berzelius of this latter mineral.

$$Na\,O,\,Si\,O_3 + 2\,(Ca\,O,\,Si\,O_3) + 3\,Al_2\,O_3,\,2\,Si\,O_3 + 7.5\,H\,O.$$

"Some remarks on three localities of Silurian Fossils in the Co. of Waterford, by Hugh N. Nevins, Esq." were read.

"In sending the accompanying specimens from Tramore, Drumcannon, and Passage, it may not be amiss to state a few facts respecting them, and mention the ideas suggested to me by their apparent connexion amongst themselves, and relation to the adjoining district.

It has been for some time known, through the researches of Captain James, R.E. and others, that fossils of a true silurian character, exist in great abundance at Tramoré, in the rocks, from the strand, to Newtown-head, and on Passage strand, or its neighbourhood; in the former of these localities the dip is about 30° and in the latter, 22° and 25° west of north.

The object of the present paper is to introduce a third and intermediate point to the notice of the Geological Society.

In passing along the road between Dunmore and Tramore, I observed that the stones used in making the new line round the foot of Drumcannon Hill were fossiliferous, and by tracing them along I discovered the quarry (a surface one) whence they had been taken. It lies between the old road and the sea, the towers on Brownstown Head bearing 30° and those on Newtown 65° west of south. The fossils were very plentiful in the soft ferruginous stone, (No. 1,) apparent dip, N. 30 W.

The natural conclusions to be drawn from the discovery of this intermediate point between two known fossiliferous localities similar in general dip, and contained remains, and so placed as to be nearly intersected by a line drawn in the direction of the strike, are—first, that it is part of a continuous line, and if so, that in the second place, this line may be made a starting point in any investigation of the country to the north west of it, in which if any organic traces have yet been discovered, they are of so indefinite a nature as to be utterly useless.

There is again another minor peculiarity which may be worth mentioning, as rather strengthening the argument.

Although the general dip is the same, the strike of the rocks at Passage is more nearly E. and W. than at Tramore. If, then, they be hereafter proved to form one continuous bed, the intermediate points must necessarily be more southerly than the true strike at Passage, and more easterly than that at Tramore would lead to: and such we find to be actually the case in the present instance. I do not as yet venture to start the foregoing as an opinion, but merely to point the locality out as a fair subject for further examination. I have not myself been able to explore the line since, but intend doing so at the first opportunity.

Should this be established, a great step will have been made

towards ascertaining the true position of the slate in the neighbourhood of the City of Waterford.

The general dip of these is west of north; but as may be supposed in a country so broken and contorted, minor irregularities occur, and it frequently happens that when the rock is metamorphic, the alteration is so great as wholly or nearly to obliterate their original structure; still, whenever a band of unaltered or only slightly changed rocks appear, the main direction is seen to be west of north, and this of course would place them in a position superior to the fossiliferous beds. In this idea I am, I believe, to a certain extent borne out by some who have investigated this portion of the Co. of Waterford, but it still calls for further research from older and more experienced hands than the writer of the present paper; who, whatever may be his wishes for the due development of this most interesting tract, possesses neither the time nor knowledge required for the proper performance of so difficult a task.

NOTE—The rock at Drumcannon contains a much greater proportion of Crinoidal remains than the others.

January 8th, 1845.—Henry Richardson, Esq. Rossfad, near Enniskillen, was elected a Member of the Society.

A paper "On the Marbles of Ireland," by George Wilkinson, Esq., M.R.I.A. &c. was read.

The Author commenced by pointing out the uses to which Marble had been applied in earlier ages, and the various modes in which it had been successively wrought. He noticed the extent to which foreign Marbles were at the present time imported for the purposes of internal decoration, while many of the native Marbles were equally beautiful and much more economical. The labour of conversion was also compared with that which the ancient Egyptians had endured in working their extremely hard Syenites and Porphyries, and the present mode of construction contrasted with the more solid and enduring methods adopted by the architects of former ages.

The physical or external characters of Marbles constitute the chief consideration with reference to their use for decoration or ornamental architecture, their colour and texture being the most important. Their chemical character has reference more to the facility with which they may be converted into use, and their capability of receiving and retaining a certain polish.

In their simplest and purest state Marbles chiefly consist of carbonate of lime, which is of a white colour; the facility of conversion of Marble is chiefly influenced by the greater or less admixture of silex; the variations in the colour arise chiefly from accidental causes,—the admixture of carbon—the stains of various metallic oxides, or the sectional outlines of imbeded fossils. The more crystalline and least earthy Marbles are the least durable, the compact or finely granular crystalline Marbles being superior to those which are largely crystalline, or of a slaty texture. Almost all the varieties burn into quick lime, several of them, however, exfoliate in their conversion before they become caustic, and fall into sand when exposed to the ordinary mode of separating the carbonic acid; such qualities are therefore very inferior for ordinary cement, as they make a costly and meagre mortar. It is, however, to their use as materials for decoration that the present observations are chiefly intended to relate. The colours of the Marbles of Ireland are almost as numerous as of those obtained from Italy; the dark colours vary from jet black to dark dove-colour, purple, blue, and grey; the light colours

vary from the pure snow-white, to the veined, cream-coloured, pink and light grey; the variegated consist of the sienna, serpentine, black and white veined, mottled, and those marked with fossil organic remains. The serpentine is here included from its common use for the purposes to which marble is applied, and from its being so commonly called green marble, although it is not, strictly speaking, a marble.

The black Marbles, which are those of most value in Ireland, are extensively met with, and belong to the formation familiarly known as the lower limestone.* The merchantable beds of best quality are met with in the Counties of Galway, Limerick, Carlow and Kilkenny; black Marble is also met with in the Counties of Mayo and Waterford. At the former places the beds have been extensively worked; the best quarries are considered to be close to the town of Galway, near the banks of Lough Corrib. The Marble occurs there in three beds, varying from about nine to twelve inches in thickness; one of these is called the London bed, most of the black Marble raised from it being exported to London. The blocks are of the average size of five to ten feet in length, and four to five feet in width, but blocks of the size of twenty feet long can be obtained; some, of the length of even sixteen feet, have been exported, and converted at the Esher-street Marble Works in London, into a magnificent staircase for the Duke of Hamilton's palace in Scotland, the wide steps, large landings, and solid carved ballustrades being formed of this marble, worked to a beautiful jet black polish; and doubtless when brilliantly lighted and surrounded by other accessories appertaining to a palatial residence, they will produce an effect of princely grandeur, leading the observer to reflect on the rude labour of those who raised it, in ignorance of its destiny after it left its native bed, and also on the numerous persons and skilful artists to whom it has given employment in its passage to its present position.

The marble beds are covered, in the new quarries, with about twenty feet of limestone, the raising of which adds much to the expense of obtaining it, although a considerable sale occurs for the limestone for common building purposes. Excepting near the Marble beds, the quarrying of the limestone is effected by gunpowder. A considerable quantity of this marble is sawn by water power into slabs, and exported from Galway in that state to England and America. It is most probable that these Marble beds embrace a considerable area, and also that they extend under the waters of Lough Corrib, with which they now are nearly on a level.

* Since reading the above, Mr. Wilkinson has been led to believe that the black marble beds belong to the lowest portion of the upper limestone.

The accompanying wood-cut* exhibits the position of the Marble

beds and the superincumbent limestone, as well as the mode of working the quarry, which is one of those last described, on the banks of Lough Corrib, near the town of Galway.

At Oughterard, (the western extremity of the limestone formation) and in several other parts, similar marble beds are met with and worked, those at Oughterard, in the opinion of the London Marble workers, contain silica in greater or less quantity, which renders the marble less valuable.

At Limerick a considerable quantity of black marble is raised and used in that locality; it is also exported. At Carlow and Kilkenny very fine black marble is raised; at the latter place the best beds, which are very thin, have, I am informed, been nearly exhausted; most of the marble obtained from Kilkenny abounds in shells which become more conspicuously marked as the marble becomes dry and exposed. Chimney-pieces made of Kilkenny Marble are to be met with in most parts of Ireland, and it is familiarly known from the extensive use which at one time was made of that material; at present that

* Taken from Mr. Wilkinson's recent work, "The Practical Geology and Ancient Architecture of Ireland."

which is of a jet black and free from shells is the most generally esteemed.

The polished surface of the black marble is considerably effaced by damp, and is both preserved and improved by being kept dry. Wherever beds of black marble are met with, they are associated with beds of limestone; the difference in quality appears to be almost accidental. Some of the over or underlying beds often present a strong contrast in the quality of the stone; in other places there is a gradation in character from the adjoining ordinary limestone to the fine Marble.

In the impure limestone formation of the calp series, beds of black marble are frequent, they are generally, in greater or less degree, marked with fossils, and are inferior to the beds belonging to the lower, or lighter coloured limestone formations; these seldom receive a good polish.

The economy of raising marble from the beds which occur in the limestone formation is dependent on the depth of the overlaying rock or soil which may require to be removed; and also on the demand which may exist in the neighbourhood for the common rock, either for masonry or for burning into lime. In some localities the limestone rock itself more than repays the cost of its removal, and in such places these considerations, and the qualities of the marble beds, will determine the question of economy in raising marble. Excepting, however, at Galway and Limerick, from which places much marble is exported, it is almost solely used in the surrounding localities for ordinary purposes. It is most extensively used for large grave stones which are prepared in slabs of three or four inches thick, by sawing, and the demand is very considerable for this purpose; the best qualities are however seldom employed thus.

Dark grey and dark mottled grey marbles are met with chiefly in the King's County and in several parts of the County of Cork; near Tullamore, marble is obtained in large blocks, which is capable of receiving a fine polish, and it is much used for chimney-piecies and work of that kind. The limestone around Cork produces an easy working marble, of a light grey or dove colour, more or less mottled, capable of receiving a good polish.

In the primary districts of the county of Donegal, a light grey and blueish grey coloured marble of close grain is met with to a great extent; but from the quantity of silex which most of it contains it is hard to work; the same kind and of a blueish tint is also very frequently met with in Connemara; marble of this description is com-

mon to most primary districts, it is compact in texture, but does not often produce a satisfactory polish. Most of the primary limestones are met with in exposed ridges of surface rock, alternating with, or imbedded between rocks of the slate formation, and the strata generally have a vertical or strongly inclined direction. In the northern portion of the County of Donegal it is, however, very frequently met with in successive, nearly horizontal beds, and is easily quarried. In the Counties of Donegal and Galway primary limestone of a coarsely crystalline texture is abundant, it polishes very well, and has considerable variety in colour.

Most of the limestones of the country which are of a fine grain and highly crystalline, are susceptible of a polish, and produce a light grey and bluish grey colour.

Of the light coloured limestones the pure white is most esteemed; it is met with in Connemara, in several localities, is exceedingly compact and hard, found in narrow vertical or highly inclined seams, between the slate rocks, and contains veins parallel with the vertical face of the seams which prevent any cubical masses, except of small size, from being obtained: the great hardness in conversion, and the difficulty of quarrying it renders the use of this material very limited.

White Marble occurs in the western portion of the County of Donegal and differs much from that in Connemara: it is coarsely granular, of comparatively easy conversion, can be obtained in cubical blocks and in great quantity; its very coarsely saccharine texture, however, is prejudicial to its use for many purposes; some of this marble has been employed in sculptures, which have been exhibited in the Royal Hibernian Acadamy. In comparison with the white Marbles of Italy, the white Marbles of Ireland are certainly inferior for sculpture, and the ordinary uses to which white Marble is applied; when, however, it can be boldly used in localities where the expense of carriage would not be very great, there is no doubt that it might be frequently employed for many purposes with much advantage.

At Cheevy, near Dungannon, a very delicate cream coloured Marble is obtained, it is very compact in texture, receives a high degree of polish, and blocks of great length can be procured. The coarsely crystalline and fossiliferous limestone at Ardbraccan produces a light coloured Marble of easy conversion.

Of the variegated Marbles of Ireland, the sienna of the best quality is perhaps the most beautiful; marble of this character is met with in the King's Co. in several places; the best with which I am acquainted,

JOURNAL

OF THE

GEOLOGICAL SOCIETY OF DUBLIN.

VOL. III. PART II. 1845. NO. I.

AT THE

ANNUAL MEETING,

HELD ON WEDNESDAY, FEBRUARY 12TH, 1845,

C. W. HAMILTON, ESQ., PRESIDENT, IN THE CHAIR.

The following Report from the Council was read:—

"The fourteenth year of the Geological Society of Dublin having passed away, the council have to render an account of the charge committed to them for that period, leaving it for the President to notice in his address the several communications made to you during the year. The Council have much pleasure in stating that the following persons were enrolled members of the Society since the last report:—

Marquis of Downshire,
Earl of Bective,
Lord Palmerston,
Sir Thos. Esmonde, Bart. M.P.
Colonel Bruen, M.P.
Patrick Byrne, Esq.
Samuel O'Neill Cox, Esq.
Frederick Darley, Esq.
C. H. Domville, Esq.
William Farrell, Esq.
Francis J. Farrell, Esq.
James H. Hamilton, Esq. M.P.
S. Jones, Esq.
J. B. Keane, Esq.
Frederick Leckie, Esq.
J. Ross Mahon, Esq.
Sir Richard Morrison,
R. Morrison, Esq. M.D.
John M'Mullen, Esq.
M. B. Mullins, Esq.
William T. Mulvany, Esq.
Parke Neville, Esq.
W. S. O'Brien, Esq. M.P.
C. S. Ottley, Esq.
Professor Phillips,
John Purser, Esq.
H. Richardson, Esq.
John Sheill, Esq.
Evelyn J. Shirley, Esq. M.P.
W. D'Esterre Smith, Esq.
Arthur Todd, Esq.
Joseph Welland, Esq.
Luke White, Esq.
W. T. Wilkinson, Esq.
Thomas Wilson, Esq.

" Your Council have effected an economical change in the form of the Society's Jonrnal, which ensures a very speedy publication of papers, and at the same time fits it for circulation, by the present admirable cheap postage arrangement, thus much increasing its utility, and giving authors of papers the utmost facility of communicating their discoveries.

" On the last anniversary valuable results were anticipated from the appointment of Mr. Oldham as Curator; these anticipations have been amply realised. In the coming year, however the Society cannot hope for the same extent of service from Mr. Oldham, owing to his deserved appointment to the Assistant Professorship of Engineering in the University, but the Council are satisfied that the Society will, nevertheless, join them in a cordial feeling of gratification at his success. Under the circumstances, your Council having accepted Mr. Oldham's resignation as Curator, have to propose to you his appointment as Assistant Secretary.

" On the last Anniversary Mr. Griffith, your Vice-President, liberally promised a donation of two thousand fossils; his great occupation has since prevented the fulfilment of this kind promise, but your Council look forward to its being realised as soon as duty will allow. In the meanwhile they pray the members, and others disposed to send in specimens to the Museum, will do so.

" An application having been submitted to your Council by the Institution of Civil Engineers of Ireland, requesting leave to hold their meetings in your rooms, the Council gladly acquiesced, feeling it their duty to aid as mnch as possible the objects of a Society to whom Geology is of so much importance.

" Although special thanks have already been given, your Council cannot conclude without noticing again the valuable donation of a duplicate set of Ordnance Maps of Ireland, presented by the Lord Lieutenant, for the purpose of enabling the working members of the Society to perform their field work with more facility.

" A list of the numerous additions made to your collections during the past year is appended, but the Council would call your attention especially to the donations received from Mr. Wilkinson, which are peculiarly calculated to show how practical professional men may aid, and may be aided by Geology."

An abstract of the Treasurer's account is subjoined, from which it appears that there is a balance to the credit of the Society, to the close of the year, of £1. 2s. 10½d., exclusive of arrears.

Abstract of Accounts of the Geological Society of Dublin, for the year ending February, 1845.

Dr.

1844.	£	s.	d.
To Balance in Treasurer's hands, on the account of last year,............................	4	2	3½
— Amount produced by the sale of Journals,......	2	2	0
— Subscription for two Life Members, non-resident,	10	0	0
— Admission Fees for twenty-seven Members,.....	27	0	0
— Annual Subscriptions,.......................	99	0	0
	£142	4	3½

Cr.

1844.				£	s.	d.
By Furniture for Shelves, purchased and put up,...				4	10	0
— Paid for Specimens, &c........................				1	14	11
— For Pannels for Fossils,........................				1	18	6
— For Printing Journals, Summonses, and Stationary,............................				25	0	1
— For Binding Ordnance Maps.................				4	4	0
— For Coals, Candles, &c................	£5	9	3			
Deduct proportion of this expense, received from the Institution of Civil Engineers,..................	2	0	0			
				3	9	3
— Curator's Salary for one year, to January,..1845				80	0	0
— Incidentals, including Postage, Carriage of Specimens, Delivery of Summonses, Porter's Wages, &c...........................				15	13	8
— Collector's Fees,...........................				4	11	0
— Balance in Treasurer's hands,................				1	2	10½
				£142	4	3½

11th February, 1845. Wm. Edington, Treasurer.

We have examined this account, and find it correct, the balance in Treasurer's hands being £1 2s. 10½d.

WILLIAM T. MULVANY, } *Auditors.*
WILLIAM MURRAY, }

19th February, 1845.

List of Donations presented since the last Anniversary.

TO THE MUSEUM.

1844.

Feb. 14.—Two Specimens of opaque Analcime, from the parish of Layd, County Antrim, from Thomas Oldham, Esq.

Four Specimens of Carboniferous Limestone Fossils, from the Co. of Derry, from Thomas Oldham, Esq.

—— 17.—A large number of specimens of rocks, and prepared building stones, from various localities in Ireland, from George Wilkinson, Esq. Poor Law Office.

A number of Limestone Fossils, from Enniskillen Quarry, from George Wilkinson, Esq. Poor Law Office.

A number of Fossils, from Benburb, Co. Tyrone, from George Wilkinson, Esq. Poor Law Office.

—— 21.—A Pair of Antlers of the Red Deer, (Cervus Elaphus,) from Ballinderry Lake, in the Co. of Westmeath, from C. W. Hamilton, Esq. President.

Mar. 13.—Specimen of the Coral Sand of Bantry, so extensively used for manure, from C. W. Hamilton, Esq. President.

Two large painted Tiles, made according to the patent process of Messrs. Davis and Co. Newcastle-upon-Tyne, from Robert Mallett, Esq.

A large hook of Iron, and a Sucker of a Pump, nowsilicified, taken from the wreck of the Royal George, at Spithead, (eighty-seven years immersed,) from Robert Mallet, Esq.

A specimen of Arigna Coal, (best quality,) from Robert Mallet, Esq.

A specimen of Arigna Iron Ore, (roasted,) from Robert Mallet, Esq.

A specimen of Lithomarge, from Portrush, from Robert Mallet, Esq.

Eight specimens of the Iron Ores of Ireland, from Robert Kane, Esq. M.D.

Three specimens of Sandstone, used in the construction of Lough Fea House, near Carrickmacross, from C. W. Hamilton, Esq. President.

—— 21.—Thirteen specimens of Limestone, and one of Sandstone, used in their works in the River Shannon, from the Commissioners for the Improvement of the River Shannon.

Mar. 23.—A complete series of the results of experiments on the the Manufacture of Crucibles from Irish Clay, from Robert Mallet, Esq.

Specimens of the various Irons and Steels used in the series of experiments on the action of air and water on Iron, (undertaken for the British Association,) from Robert Mallet, Esq.

—— 26.—Four specimens of Wire Rope, from Robert Mallett, Esq.

Six Cast Metal Stands for Cases, with Wrought Iron Stays, &c.

—— 29.—Specimens of Fossils from the Banks of the Tagus, at Lisbon, and from Mayence, from Captain Nelson, Royal Engineers.

Fossils from the Upper Chalk, at Warminster, and from the Upper Oolite, at Westbury, Wiltshire, from Capt. Nelson, Royal Engineers.

Some Silicified Woods from Antigua, from Capt. Nelson, Royal Engineers.

Apr. 10.—Six specimens of Fossil Plants, from Scotland and Ireland, from T. Oldham, Esq.

Casts of the Head and Horns of Bos Longifrons, from various places, from R. Ball, Esq.

—— 26.—A series, exhibiting the several stages in the manufacture of Zinc and Copper, from Messrs. Williams, Foster, and Co. through R. Mallet, Esq.

Portion of a large Orthoceras, from Co. Kildare, from T. Oldham, Esq.

—— 27.—Several specimens of Fossils, from the supracretaceous gravel, the chalk and lias of Wiltshire, and Gloucestershire, from C. B. Lane, Esq. through Mr. Oldham.

May 8.—A complete series of specimens, illustrative of his memoir on the Geology of parts of Mayo and Sligo, from Ven. Archdeacon Verschoyle.

—— 15.—A specimen of the Galway Green Serpentine, and of Amethystine Quartz, from the Co. Galway, from Mr. J. Dillon, Slateford.

—— 22.—A large Vertebra, of the Ichthyosaurus, from the Dorsetshire Lias, also a Gryphœa Incurva, from Capt. Nelson, Royal Engineers.

June 5.—A large Cyathophyllum, from Benburb, from W. Murray, Esq.

Two specimens, procured at the depth of one-hundred and eighty feet below the surface, in the sinking for the Artesian Well, in Trafalgar Square, London, from T. Hutton, Esq.

June 19.—A specimen of Ore in the matrix, from the Silver Mines of Peru, from Wm. Andrews, Esq.

Augt. 10.—Several specimens of Fossil Plants, from the Coal Mines of the Co. Tipperary, from Mr. P. Fenlon, through Mr. Oldham.

—— 21.—One specimen of common Fluor Spar, and two of Limestone, from the Mumbles, Derbyshire, from T. Hutton, Esq,

—— 22.—Specimens of the Building Stones used at Bristol, and of several other economical products from that neighbourhood, from C. B. Lane, Esq.

Specimens of Plagiostoma, from the Lias, near Bristol, from C. B. Lane, Esq.

Oct. 22.—Nine specimens of Shells from the Tertiary Clays of Bute, from J. Scouler, M.D.

—— 24.—Specimens of Limestone from the Co. Fermanagh, from H. M. Richardson, Esq.

Specimens of Carbonate of Lime, from Clara, King's Co. from Robert Mallet, Esq.

Nov. 6.—A large specimen of Lignite, found in sinking a well in the Co. Tyrone, fifty-seven feet six inches below the surface, from Wm. Murray, Esq.

Some Fossils from the Limestone at Benburb, from Wm. Murray, Esq.

Dec. 6.—Fossils from the Silurian Rocks of the Co. of Waterford, from Hugh Nevins, Esq. Waterford.

1845.

Jan. 1.—A specimen of Natrolite, from the Co. of Antrim, from J. MacDonnell, Esq. M.D.

—— 8.—Series of specimens of the Marbles of Ireland, (polished,) from George Wilkinson, Esq.

TO THE LIBRARY.

1844.

Feb. 17.—Keilhau's Gæa Norvegica, with a series of thirty-three specimens, from the district described therein, named and referenced, by Professor Keilhau himself, from C. W. Hamilton, Esq. President.

—— 21.—The Palæozoic Fossils of Devon, Cornwall, and West Somerset, described by Professor Phillips, from C. W. Hamilton, Esq. President.

A Geological Chart, (coloured,) from Thomas Austin, Esq. Bristol.

The Transactions of the Geological Society of Manchester, Vol. I. from the Society.

The "Climate of the Coal Epoch," a pamphlet by Robt. Harkness, Esq. from the Author.

Feb. 21.—On the great Lancashire and Cheshire Coal Field, by E. W. Binney, Esq. from the Author.

Observations on the present state of Geological Enquiry, as to the origin of Coal, by John Hawkshaw, Esq. F. F.G. &c. from the Author.

Mar. 3.—The Ordnance Survey Maps of the Co. of Dublin, in twenty-eight sheets, with Index Map, and one Sheet of the City plan, from his Excellency the Lord Lieutenant through Col. Colby, R.E.

— 13.—Two Coloured Drawings, representing the Contorted Strata on the Banks of the Boyne, near Beau Park House, from George Du Noyer, Esq.

— 20.—Proceedings of the Royal Irish Academy, Vol. I. and II., Parts I. II., and III. from the Royal Irish Academy.

— 28.—Deposited with the Society, two vols. folio, Le Regne Animal, Dispose en Tableaux Methodquies, Par L. Achille Comte, by Thomas Hutton, Esq.

Third Report on the Action of Air and Water on Cast Iron, Wrought Iron and Steel, by Robert Mallet, Esq. (from the reports of the British Association,) from the Author.

April 4.—The third, fourth, and fifth annual report of the Dublin Natural History Society, from the Society.

May 8.—A copy of the Railway Map of Ireland, coloured to represent contours at different levels, from Capt. Larcom, R.E.

June 5.—An essay on Solid Meteors and Aerolites, Meteoric Stones, &c. by Peter A. Browne, L.L.D. &c. &c. Philadelphia, from the Author.

Sixth Annual Report of the Dublin Natural History Society, from the Society.

— 6.—The Industrial Resources of Ireland, by Robert Kane, M.D. &c. &c. from the Author.

— 10.—An Engraving, representing the Artesian Well, at Grenelle, from Thomas Hutton, Esq.

Augt. 6.—A complete series of the Ordnance Maps of Ireland, embracing thirty counties, (all as yet published,) from the Lord Lieutenant, through Colonel Colby, R. E.

The Report of the British Association for the advancement of Science, for the year 1843, (Cork,) from the Association.

— 21.—One Map, coloured Geologically, of the Alps of Savoy and Switzerland, from Thomas Hutton, Esq.

One Map of Mt. St. Gothard, and the Mountains and Valleys which surround it, from T. Hutton, Esq.

One Map of France, the low countries, and neighbouring district, from Thomas Hutton, Esq.

Sept. 2.—Address to the Mayor and Members of the Artesian Well Committee, at Southampton, on July 27th, 1844, by the Rev. Dr. Buckland, from the Author.

Oct. 22.—Synopsis of the characters of the Carboniferous Limestone Fossils of Ireland, drawn up by Mr. McCoy, from Rd. Griffith, Esq.

Dec. 10.—One large Print, framed and varnished, representing the Distribution of Organic Life, on the surface of the earth, from Thomas Hutton, Esq.

1845.

Jan. 27.—The Transactions of the Royal Scotish Society of Arts, (a complete series, as far as published,) from the Society.

Resolved.—That the Reports now read be confirmed, and that such parts of them, together with the Treasurer's account, as the Council may think fit, be printed, and circulated among the Members.

The Balloting Glasses having been duly closed, and the Lists examined by the Scrutineers, the following Gentlemen were declared duly elected the Officers of the Society for the ensuing year:—

President,

C. W. HAMILTON, ESQ. F.G.S.L. M.R.I.A.

Vice-Presidents,

RT. HON. THE EARL OF ENNISKILLEN, F.G.S.L. &c.
RICHARD GRIFFITH, ESQ. F.G.S.L. M.R.I.A. &c.
JAMES APJOHN, ESQ. M.D. M.R.I.A. Professor of Chemistry to the Royal College of Surgeons, &c.
JOHN SCOULER, ESQ. M D. Professor of Geology and Mineralogy to the Royal Dublin Society.
JOHN PHILLIPS, ESQ F.G.S.L. Professor of Geology and Mineralogy in the University of Dublin.

Treasurers,

WILLIAM EDINGTON, ESQ. M.R.I.A.
ACHESON LYLE, ESQ. M.R.I.A.

Council,

M. M. O'GRADY, ESQ, M.D. M.R.I.A.
JOHN MACDONNELL, ESQ. M.D.
FRANCIS WHITLA, ESQ.
JACOB OWEN, ESQ. M.R.I.A.
WILLIAM MURRAY, ESQ. R.H.A. M.R.I.A.
ARTHUR JACOB, ESQ. M.D. M.R.I.A.
THOMAS HUTTON, ESQ, M.R.I.A.
REV. H. LLOYD, D.D. F.T.C.D. M.R.I.A.
GEORGE WILKINSON, ESQ. M.R.I.A.
ROBERT CALLWELL, ESQ. M.R.I.A.
WILLIAM ANDREWS, ESQ, M.R.I.A.
CAPTAIN JAMES, R.E. M.R.I.A.
JOHN ROSS MAHON, ESQ.
WILLIAM T. MULVANY, ESQ. M.R.I.A.
ROBERT KANE, ESQ. M.D. Professor of Natural Philosophy, Royal Dublin Society, &c.

Secretaries,

ROBERT BALL, ESQ. M.R.I.A. Sec. Royal Zoological Society of Ireland; Local Sec. Bot. Society of Edinburgh.
ROBERT MALLET, ESQ. M.R.I.A. Mem. Inst. C.E. &c.

Assistant Secretary,

THOMAS OLDHAM, ESQ. F.G.S.L. M.R.I.A. &c.

The President then delivered the ANNUAL ADDRESS. After the address had been concluded, the following Resolutions were passed unanimously:—

That the thanks of the Society be presented to the President for his address just read, and for his zealous and untiring efforts in the cause of the Society.

That the warmest thanks of the Society be presented to the several Officers of the Society, for their constant attention and anxious endeavours to promote the objects of the Society, during the past year.

ADDRESS.

GENTLEMEN,

The honor and difficulty of looking backward and summing up the proceedings of the past year, now devolve upon me—I feel both deeply.

I shall restrict my observations in this address, to those subjects which have been brought before your notice by members of this Society, and endeavour to point out the channels in which further investigation is desirable. I may congratulate you, in looking back, upon every evening of this Society's meeting having been fully occupied with the communication of original papers and animated discussions. We cannot attach too much value to the information of the Geologist, Chemist, Zoologist, and Botanist thus brought to bear on the same science. We must feel thankful to have lived to see another anniversary collect us together; and if one is absent from among us, whom ill health has driven to a sunnier clime, we all unite in the hope that our late President may soon be restored to us perfectly convalescent. The Report informed you of the loss which this Society has sustained by the removal of your Curator, to whose zeal and ability your Society is so much indebted. He now occupies an honourable position in our university, but I feel confident, that under the new arrangement, by which he becomes your Assistant Secretary, we shall still reap the full benefit of his active services. Indeed one of the difficulties which this Society has to contend with is, that all of our Members, I who address you, and you whom I have the honor to address, have only moments snatched from a life of busy cares to devote to the attainment of its objects; but we struggle in hopes that the time may come when men of leisure and wealth will engage actively in carrying them out more effectually than we have the power of doing.

In the list of donations which you have heard read, there are a few to which I would especially direct your attention. 1st—a duplicate copy of the Ordnance Maps, presented by the government; this is a great boon, and we are grateful to Captain Larcom for the interest he took in obtaining it for the Society. The intention is, that these Maps should be lent to Members who wish to record upon them Geological observations, and restore them to the Society, there to form a register of facts observed, which may be tested and proved by the subsequent observation of others upon the same sheets. 2nd—Professor Kane's work on the Industrial Resources of Ireland—a volume replete with information,

and conceived in the true spirit of philanthropy; for it is upon our own exertions in developing these resources that the prosperity and happiness of our country depends, much more than upon legislative interference or protection. 3rd—Mr. Griffith's Synopsis of the Fossils of the Carboniferous Limestone of Ireland; a description of the Fossils in Mr. Griffith's cabinet, by Mr. M'Coy, printed at Mr. Griffith's expense, but not yet published. Of Mr. Griffith's part, in this work, there can be no second opinion, and we must never allow subsequent discoveries tending to invalidate the accuracy of his maps, or the conviction, on our part, that he has merely traced outlines, which require to be filled up by long, laborious, and accurate observations, to throw into the shade, or make us forgetful of what we really do owe him, as having worked out single-handed all the great relations of rocks in the Western and Southern, as Mr. Weaver and others did upon the Eastern and Northern coasts of Ireland; eagerly availed himself of the opportunity afforded him, of extending his observations and increasing his collections by means of the valuators scattered over the country under his command, and now generously communicated to the public, the result of their discoveries. Of Mr. M'Coy's share in the work, I do not feel myself competent to enter into any detail of critical examination; I shall only press upon the attention of Naturalists the importance of accurately sifting the grounds upon which so many new species have been determined. In approaching such a task, with a spirit of scepticism, a duty will be performed to science, without any disrespect being shown to the authority of Mr. M'Coy, as in a matter of such importance it is essential that there should be the concurrence of several witnesses. With respect to fossil shells, we are bound to exercise great caution—we sometimes see distinctions of species, founded upon some character, observed in one shell, or one fragment of a shell; and if we turn to recent conchological cabinets, and observe the variety exhibited in any suite of shells, of one species but of different ages, and found under different conditions, we shall feel that the character upon which a distinction is rested, should be very clear, or found constant in a great many specimens, unless it be such a character as would necessarily imply a different habit or conformation in the animal which lived in it. The defects in this work, which strike the reader at first sight, are the total want of localities, either geological or geographical; the want of accurate reference to the plates and descriptions of previous authors; and the want of distinction in the plates. To refer to only one example of what I mean by want of distinction, if you consult Pl. 15, figs. 12 and 21, you will see how little the difference between *Pectens micropterus, and leiotis*, is borne out by the plates. Such, however, are merely negative defects, and if Mr. M'Coy is able to maintain the discovery of so many species as distinct, and hitherto unnoticed, this work will become one of great value and authority.

4th—A suite of specimens from the Pyrenees, with a catalogue of names and localities, presented by our fellow-associate, Mr. Owen Blaney Cole: to the student these collections are of great value; they enable him to read the works on the Geology of distant countries, and explain the synonymes; they give him a Dictionary of the language of foreign authors. We have now in our cabinets well-named specimens of the German, Swiss, and Pyrenean rocks; and this addition to the collection carries along with it the feeling, that those, who took an interest in our proceedings here, did not lose that interest in their distant wanderings.

Associated as we are for the promotion of the Science of Geology in Ireland, we cannot feel indifferent to other efforts made in the same direction; nor can I omit all allusion to them. The establishment of a School of Geology, in Trinity College, and the appointment of Professor Phillips to its chair, are great steps towards raising an interest in Geology, and its application to useful purposes, among the students of our University; and the Museum, the arrangement of which has been placed under the direction of our excellent Secretary, Mr. Ball, bids fair to compete, in the interest of its contents, and the order in which they are displayed, with any Museum in the country.

As to the Geological portions of the Ordnance Survey, I regret that I cannot look back upon the past with any degree of satisfaction. I need not detail the events of the last eight years—you are all familiar with them. You saw a body of Engineers trained to make a Geological Survey of the country; you saw them labouring on, overcoming difficulties, accumulating facts, publishing the first part of a great national work—when suddenly the work was suspended, the corps disbanded, and their collections buried in obscurity, or sent to London. For the space of two years that portion of the survey has been wholly neglected in Ireland, while it was progressing rapidly and without check, under Sir H. De La Beche, in England, by whom every bed of rock has been accurately surveyed—every fossiliferous bed described according to its organic remains: and the maps and sections exhibited at York abundantly prove that the work has been so done as to leave little undone.

We petitioned the minister that that work should be extended to Ireland: I can now announce to you from the highest authority, that this work is to be extended to Ireland, and upon an increased scale of liberality.

The original fault was in making the Geological Survey a purely military work—one of mere mechanical skill, by which a parish or a barony was to be done within itself, and reported on before the boundary was passed; it was treating Geology as if it were a work which could be done by the day or by the piece; it was throwing experience, and that tact which experience gives, out of the question, and acting upon the supposition that a clinometer could be put into the hands of a sapper, to be used as mechanically as a theo-

dolite, wholly forgetful of this, that the theodolite itself reveals the errors of the observer, while in geological observations there is no such proof. The report of the sapper was to be taken as authority upon the most abstruse instances of relation; and the head, under whose superintendence all such observations were to be reduced and regulated, was liable, however zealous, to be led into error, without any means of correcting it. If the object of the survey had been merely to collect specimens, and make unconnected observations upon each rock visible on the surface of the country; and if this work could have been done by the ordinary machinery of the Ordnance Survey, it ought surely to have been conducted pari passu, and would now have been as nearly completed as the triangulation, with little additional expense to the country. If a fuller work were contemplated—one in which the application of experience and science was essential to success, we have surely reason to complain of the mode in which time, labour, and money have been thrown away, and a great national work taken up on wrong principles, and pushed forward or suspended according to the caprice of a Master General of Ordnance.

Under the plan now proposed by Government, the control of the Master General of Ordnance will cease at the close of this present financial year, and the management be transferred to the Board of Woods and Forests. Sir Henry De La Beche is to be Director General, having Mr. Ramsay as local Director in England, and Captain James, in Ireland. Professor Playfair and Mr. R. Phillips are to conduct the analyses in England, and Professor Kane in Ireland. Professor Forbes is to be palæontologist for the United Kingdom, and will draw and describe the fossils in one uniform work, Professor Owen undertaking the Mammalia. An Economic Museum is to be immediately opened in Dublin, on the same plan as the Economic Museum of London; and every possible means will be taken to ensure uniformity in the survey of the United Kingdom. I think that this arrangement promises well, and hope, ere the close of this year, to see this important national work rapidly and effectively advancing.

I now turn from these objects of general interest, to an enumeration of the subjects which have occupied your attention during the past year.

The first paper, both in order and interest, was that which Mr. Mallet read upon the "Relations of Molecular Forces to Geology." The author eloquently describes the importance of accurate measurement applied to the results of forces which we see in daily action around us, and in which we may trace the laws which guide them, until analogy more clearly enables us to reason from effects yet visible in nature's older rocks, to causes now no longer in action. He then proceeds to enumerate a variety of instances in which a change in the internal arrangement of the molecules may take place without any considerable alteration in the outward form; but with a

change of volume which, although minute in reference to a small scale, yet may, upon the grand scale, have exercised a powerful agency, producing elevation and distortion in strata which were originally deposited horizontally.

He gives tables embodying all the knowledge that we already possess concerning the expansion and contraction of bodies, under the influence of either new combinations, or a change in the state of arrangement of their particles, and then applies the ratio of expansion to shew the effects which would follow the application of a high temperature to the masses of clay or gypsum which form the London and Paris Basins.

Such are not vague and useless theories; and while we should jealously restrict geology to the accumulation of facts, upon which, when they shall form a perfect chain of induction, some future cosmogonist may, upon true premises, build up a "Theory of the Earth," more consistent with reason than the wild speculations of some of our old philosophers, yet we must acknowledge the great value of occasional stretches into the yet undiscovered realms of science. We can see that Mr. Mallet's speculations are in the right direction; like those of a mariner who, accurate in his bearings, and cautious in his soundings, may steer securely into the cloud of night, where the careless or reckless would become but the sport of the winds and waves. Mr. Mallet has thus made a valuable addition to the information we have derived from the investigations of Mr. Babbage and Mr. Fox, and pointed out the channel in which it is desirable that observations should be continued; and we shall look forward anxiously to his adding to our information. I shall not attempt to describe any of the experiments by which he showed the various changes which take place in the internal constitution of bodies, while their outward form remains the same; or enter into the details already familiar to you; but there is one which I cannot pass by without referring to a remarkable corroboration of Mr. Mallet's views. In describing some changes which take place in bodies, under conditions of mechanical arrangement, he quotes, as an example, Prince Rupert's drops, in which melted glass, cooled suddenly, contracts unequally, and is thrown into a state of tension, which, when the unstable equilibrium of the particles is disturbed by a blow, causes them to fly asunder with great violence. He then says, it is to be regretted that Humboldt does not appear to have tried whether the large glassy nodules he found in the plains between Bogota and Quito, would fly to pieces on being fractured by a blow; but, even though their amount of tension might not be sufficient to produce disruption, the fact of its existence under such circumstances as above cannot be doubted, nor hence the analogy of Rupert's drops.

Now on referring to the *Comptes Rendus* for the 2nd January, 1844, you will find an account by M. Damour, of a spheroidal mass

of obsidian, which he attempted to saw into two parts, in order to examine its internal structure, but which, during the operation, exploded violently and shivered to pieces. M. Damour also draws the analogy between the obsidian and Prince Rupert's drops.

Mr. Mallet at the close of his paper gives some curious speculations upon the origin of Quartz veins in Granite:—"As the crystallizationof Granite has resulted from cooling, the progress of crystallization must have been from the surfaces cooled towards or into the mass. Now if the Felspar crystallize first, it will take up such a portion of the silex as is due to its own composition, and by expanding as it crystallizes, will push the still pasty Quartz in a direction contrary to that of the cooling agent. The Mica, in crystallizing next, will do the same, and finally, such portion of the Quartz as is entangled amongst their crystals, will crystallize too, leaving the residual quantity pushed into the still hottest part of the mass, to form a Quartz vein, which may be in any direction according to the position of the cooling surfaces; and will have its form likewise dependant upon the latter, in some degree."

His ideas correspond in a remarkable degree with those of Darwin, where he thinks it possible that the dykes which traverse granitic rocks may have originated in fissures of the partially cooled rocks of the Granite and Metamorphic series, having been filled by the more fluid parts, consisting chiefly of Hornblende, oozing out and being sucked into such fissures; and questions, whether the fine ramifications from these dykes may not be viewed in the light of feeders rather than injected veins; and whether great masses of Plutonic rock may not have been thus drained of their more liquid constituents, into deep and unseen abysses, afterwards to be brought to the surface, in the form either of injected masses of Porphyry, or Green-stone, or Basaltic eruptions.

The next two papers which came before the Society relate to Metamorphism—a subject, in directing your attention to which I have always felt much interest, as it appears to me that it has not been cultivated with as much energy as other sections of Geology, if it has not, perhaps, even been in some measure lost sight of and retrograded since the days of Hutton and Macculloch—a subject, too, peculiarly interesting to Irish observers, who meet upon every side, examples of every form of its occurrence.

When miners first felt the importance of studying the nature of the earth, and classifying the different rocks so as to be able to recognise their occurrence in stated succession and so charting the field of their subterranean researches, outward form, colour, texture, and such of the more easily distinguishable attributes of matter, formed the groundwork of the first great attempt at classification; but it was impossible for minds occupied with the properties not to seek to arrive at some conclusions with respect to the origin and history of

rocks; and according to the bent of each genius, or the impressions derived from the circumstances and conditions of those rocks with which each eye and mind became earliest familiar, arose two great speculations—one attributing all the phenomena to the deposition of sediment from a watery menstruum; and the other deriving the same rocks from the gradual cooling and solidification of a mass of molten matter. The advocates of each arranged themselves in separate ranks, under the name of Neptunists and Vulcanists. I shall not here detain you with any reference to the names of authors, or any history of the progress of discovery—details with which you are already familiar. I shall merely point to the lesson so often brought before us in following the history of any science—how great errors men fall into, when they limit the laws of nature to the production of one effect by one constant cause. It would ill become a grave address were I to indulge in a favourite contemplation of those harmonious repetitions, by which nature seems to echo the same ideas, from the animal to the vegetable, and thence to the mineral kingdom—to bid the same substance crystallize in waving wheaten straw, or in the burning lava stream, or form the transparent flood of Quartz, in which the rapid progress of tropical decay has been suddenly checked, and every fibre and vessel in woods of the most delicate structure left floating—to draw the earthy phosphate from the solid rock, then mix it in the cereal food of man, and bid it form the strength of his bones, whereby he is enabled to stand erect and look upward. I refer to them merely as an instructive check to the habit of generalising unguardedly from effects to causes—a habit which led these great men to range themselves in opposition under theoretical banners, while with admirable accuracy of observation they were all laying the foundation of Geology as a science. Upon that foundation the Geologists of this century, laying together the results of observation, and the deductions of reason, have built up a solid structure, composed of indisputable facts, collected from every part of the earth, with a zeal and perseverance which has won for the Geological Society of London the proud motto of

Quæ regio nostri non plena laboris.

Every Geologist now recognises a triple category under which he is able to arrange and classify the rocks he meets with. He watches the change that takes place in matter before his eyes; peers, as it were, into the laboratory of nature; and then reasons by analogy as to her "modus operandi," in the distant past: he sees the volcano pouring forth lava—liquid rocks, which when they cool, solidify, crystallizing into different forms; and he finds by analysis that every variety of form exhibits also a variety of constituents, or a different proportion in the combination of the same constituents; and that thus outward and sensible properties enable him to know the inward and chemical constitution of the separate crystals of

which the solid lava consists: he then sees that the lava bursts through the solid rock, elevating and distorting some beds, and overflowing others: these are phenomena of recent occurrence in volcanic regions. Now among the older rocks he finds evidence of the operation of the same causes, he finds rocks containing the same minerals united together in a similar manner, and producing the same effects, of disruption, elevation, and overflow, upon the adjacent beds: he then turns to the shores of our seas; he finds mud and sand accumulating in regular layers, and solidifying from the infiltration of water charged with cement, or some chemical change by which a cement originates in the re-arrangement of the constituents: he finds the remains and the traces of animals, buried and marked in these recent rocks; and he doubts not of the analogy which points to a similar origin in those older rocks, which he finds invariably occupying the same relative position, and containing remnants of vegetable and animal life, the products and inhabitants of earth, at a time when these successive deposits formed the then surface of ocean and land. He ranges under the heads of igneous and sedimentary all those ancient products of water and fire; and the two antagonist theories are found to be equally applicable to different circumstances—the Neptunist and Vulcanist are both equally right, and equally wrong.

But there are many rocks which it has been found impossible to arrange under either of these heads; they bear distinct evidence of having been deposited under the same conditions as the acknowledged beds of sedimentary origin, and contain frequently the remains of organic life, while at the same time they approach so nearly in crystalline structure and the nature of imbedded minerals, to the types of undoubted igneous rocks, that they have been placed in a class by themselves, and called *Metamorphic*. The definition is easy—a rock which was originally deposited by water, and subsequently altered by the addition, subtraction, or re-arrangement of its constituents, so as to wear the semblance of an igneous rock. But the great difficulty of determining at what period the evidence of stratification disappears, and the evidence of volcanic action begins to show itself distinctly, renders these rocks the most obscure of the pages in that history which the Geologist aspires to unroll. And while most have pressed forward eagerly to arrange the stratified rocks, according to the remains of organic life which they contain, and follow out the brilliant discovery of Dr. Smith, that the different rocks, as they lie one over the other in constant succession, hold within them evidences of the occupation of the earth's surface at the time of their deposit, by plants and animals so distinct as to mark epochs in their history; while the Zoologist and Botanist have united in the fascinating pursuit, and restored to the mind's eye the very appearance and habitation of earth's earliest denizens, it is not surprising that the dry study of rocks from which little knowledge

can be obtained, without the laborious and costly investigation of the Chemist in aid of the Geologist should not have kept pace with the other branches of the science; and that such works as those of Keilhau, &c. should startle us with the effect of novelty, while we have only to turn to the pages of Macculloch and Playfair, to see the progress which was formerly made in the accurate study of Metamorphic phenomena. Even in recent Geological works we see how small a compass the consideration of these rocks occupy, and how vaguely all crystalline rocks, containing Hornblendic minerals, and evincing but obscure traces of stratification, are referred to eruptions from some unknown source in central earth.

In approaching the examination of these rocks, while we jealously watch lest any preconceived ideas as to their origin, should lead our minds to attach undue influence to appearances or facts, which, taken singly, might lead us to a different conclusion from what they would do, when forming part of a comprehensive and rigourously accurate induction, we must, on the other hand, struggle to free ourselves from the trammels of those ideas which have so long occupied our minds that they give a colour to our observations, and make us rather commentators upon the translation of others, than humble readers of the great book of nature as it lies open before us. Thus we call that rock which we tread upon, or hold a specimen of in our hands, rigid, solid, and fixed, in the character and relation of its constituents; but if we saw that rock into thin plates, we find that it bends and resumes its position with all the elasticity of a wooden plank, and if we carry out the proportion between its extent of surface and flexibility, to the great mass of rock which forms the crust of our globe, we shall grow to consider it, in reference to great changes of level, to be as pliable as a garment. Again, when we see the proofs brought forward, by Mr. Mallet and others, of the internal changes which take place in the solid metal and rock, whereby elective affinities are seen to play, and molecular disturbance and re-arrangement give rise to a totally distinct mineralogical character (if more slowly, as distinctly as in the solutions of the laboratory,) we look no longer on the rock as fixed and unalterable, but as a shifting moving mass, in which we recognise not one, but a past and present character.

We must study accurately the position in which these rocks are found, and when all traces of stratification are absent, compare the phenomena with those described by Daubeny, Scrope, Darwin, and other writers on the Geology of volcanic districts, and not rest satisfied until we have established a direct analogy between the appearances of the past, and the forces of the present age.

On May 1st I brought before you the result of a few days' observation in the Trap district of Limerick. I was, I confess, startled at finding appearances so different from what the descriptions of previous authors had led me to expect; and I looked

forward with anxiety, in the hope that some, who had more leisure than I have, would enter upon a more rigorous examination of that district. What we previously knew of that district was thus briefly alluded to :—" The County of Limerick is principally a limestone plain, interspersed with trap rocks. Mr. Weaver (G. T. Vol. 5, Part 1) had described it as 'constituted of seven or eight great alternating beds of limestone and trap.' Dr. Apjohn (Journal Geol. Soc. Dub. Vol. 1, page 28) next denied that the trap was stratified, and said that Mr. Weaver's conclusions were 'entirely unsupported by facts.' He also described the limestone as lying on the trap which had elevated and disrupted it. Mr. Ainsworth, in a further account of these rocks, read before the same Society, expressed his opinion that some of the traps were altered arenaceous rocks, and others effused in beds or dykes. (Jour. Geol. Soc. Dub. Vol. 1, page 112.) Dr. Scouler, in the same Journal, (Vol. 1, page 185) denied that the trap rocks have sent forth any dykes or veins, or have spread in sheets over the country, but thought the detached masses had all been elevated after they had acquired some solidity, and in every case protruded through the limestone. In Mr. Griffith's Map these rocks, in all their varieties, are comprehended in one class, described in his explanatory synopsis by the comprehensive and all-fitting term of 'Trap Breccias, Metamorphic Breccias, Porphyritic Wackes, with occasional Greenstone and Greenstone Porphyry, which have been erupted'—a description which would apply to all of the previous varying opinions."

I produced sections to show that the beds of so-called trap agreed in relative position over a great extent of country, lay conformably to the subjacent limestone, and graduated into it and into each other, so as to convey a distinct idea of sedimentary origin. I compared hand specimens of each variety with those collected by Sir Henry De La Beche, in Cornwall, and found them identical in character with those which he calls volcanic ash, and supposes to have originated in the ashes of a volcano falling into water, and mixing with sand and pebbles in a sedimentary deposit. My own impressions led me rather to the opinion, that these rocks were metamorphic; and the great difficulty I met with was, that the appearances of metamorphism graduated in intensity upwards, although I saw no evidence of these rocks having been ever covered by an overflow of lava. I subsequently visited Croghan Hill, in the King's Co., and found that like the Limerick hills, it consisted of a trap rock, wearing all the same appearance in mineralogical character and stratification, and lying conformably upon the subjacent limestone. At the next meeting of the Society, Dr. Scouler read a paper upon the "Mineral Structure of Porphyries," in which he described erupted and metamorphic rocks, as wholly undistinguishable in their mineralogical character, and to be separated only by the fact of their having flowed or not. He described a very interesting case of metamorphism in the

Conglomerate of the old red sandstone near Tramore, in the County of Waterford, where a dyke has traversed it, and at the point of contact, the pebbles of the Conglomerate have undergone a remarkable change, so that a hand specimen might be mistaken for a fragment of globular Porphyry—the pebbles have become round, their internal structure is changed, and they are no longer masses of homogeneous Quartz, but are composed of alternate coatings of Quartz and Felspar, so that the spheroids call to mind those of the orbicular granite of Corsica.

I shall now leave the metamorphic rocks, only urging upon you the necessity of patiently investigating them; there is scarcely a County in Ireland that will not afford a rich field for observation, but I may point to the plains of Limerick, and the flanks of the Mourne mountains, as peculiarly worthy of study. The labours of Daubeny, Scrope, and Darwin enable us to become familiar with the actual phenomena of volcanic action, and we must carry them along with us into the study of the older rocks. Among the most striking of the facts brought to light by the researches of Darwin among the Islands of the South Pacific, are the ejection of lime in almost a pure state—the amalgamation of the hot stream with the older beds of Lava which it traverses—the formation of volcanic Conglomerates—the gradual passage from the overflowing Lava into the metamorphic rock, proving, that at the time of the overflow they were neither of them passive—and the tendency of the older beds of Lava to reverse their original planes of inclination, and appear to dip towards the source from which they originally flowed.

But nature is often more easily read in her minute and simple, than in her vast and complicated works; and the study of metamorphic changes, which take place in the simple minerals, will naturally lead to accurate conclusions as to her operations in the more complicated rocks; and here I must direct your attention to the valuable work of Professor Blum, upon the Pseudo-morphism of the mineral kingdom. He gives tables of the changes which are known to take place in the simple minerals, arranged under two heads:—

1st. The *conversion* of one mineral into another.

2nd. The *substitution* of one mineral for another.

The conversion of one mineral into another he subdivides according as it takes place, by the subtraction, addition, or re-arrangement of its constituents. The substitution, according as one mineral fills the place, and so moulds itself into the form of another, or merely incrusts it.

We see in these descriptions, that although sometimes the play of elective affinities is free, and the change from one mineral into another complete, yet frequently the substance is altered, while the form of the crystal remains the same; and nature reveals to us every step in the transmutation of Quartz, Felspar, Mica, Garnet, Hornblende, &c. into Steatite—of Garnet and Hornblende into

Chlorite—of Andalusite, Tourmaline, and Wernerite into Mica—of Hornblende into Jasper, Augite into Opal, &c. These are subjects of great interest to the student of metamorphic rocks; the facts appear to be indisputable; their causes, the way in which they are produced, we cannot explain. The Chemist has not penetrated into the depths of his science deep enough to be able to throw light upon these difficulties; and although, when the Geologist recognises the appearance and disappearance, and substitution of constituents, such as, for example, lime and silex, he is tempted almost to doubt whether the analyst has yet seen the extreme point to which matter is divisible; yet such doubts cannot help him—he must carry on his work of observing the circumstances under which these phenomena occur, while the Chemist carries on the work of analysis. And each will then kindle a light to guide the footsteps of the other into these obscure regions.

In the month of June Mr. Oldham read a paper "On the rocks at Bray Head;" it contained two very important corrections of Mr. Griffith's map. You are aware of Mr. Griffith's having considered and coloured on his map, the Quartz rocks which extend from Bray Head to the Hills of Forth, in the County of Wexford, as masses of Quartz intruded among the slates, which he supposed to rest unconformably upon them. This view Mr. Griffith had maintained with reference to Bray Head in particular, and exhibited sections in support of his opinions, on the preceding evening meeting of the Society. Mr. Oldham maintained, on the other side, the evidences of its mechanical origin, of its interstratification with the slates, and of its forming only a minor and subordinate member of that series of slate rocks which rests immediately upon the granitic axis of the Wicklow mountains. I am inclined myself to lean strongly to Mr. Oldham's view. In 1838 I examined the Hills of Forth, in the Co. of Wexford, and saw that they were distinctly stratified; and subsequently to Mr. Oldham's making me acquainted with his observations at Bray Head, I examined the Hill of Carrick-mac-Reilly, near Glanely, in the Co. of Wicklow, which had hitherto been represented as one mass of Quartz rock, and found that it really consisted of two disdistinct stratiform masses, whose relation to the accompanying slates was precisely such as Mr. Oldham has found to exist at Bray Head. These beds of Quartz (if such they be) are well worthy of being accurately mapped out, as affording a point of reference in ascertaining the place of the upper and lower slates.

The remainder of this paper is upon a subject which has also been brought before you by Mr. Griffith and Mr. Nevins—the latter, a new contributor, whom we must look forward to as likely to prove a valuable accession to the ranks of our observers. Mr. Oldham "at the meeting of the British Association in Cork, (August, 1843) had mentioned that the silurian slates of Waterford, instead of forming a small and isolated patch, as shewn on Mr.

Griffith's map, really were a portion of a very extended region which passed with a tolerably regular strike across the estuary of the Suir, into the Co. of Wexford. He was also aware of the occurrence of fossils, further north in the Co. of Wicklow; but not sufficiently acquainted with the details to enable him to state the fact clearly. He had since traced them in the neighbourhood of Rathdrum, in Wicklow, where it appeared they had also been found by Mr. Griffith; and still further north than Mr. Griffith had observed them, near the village of Newtown-Mount-Kennedy; and he did not hesitate to state his conviction, that the fossiliferous series was continuous from Waterford to the immediate vicinity of Dublin." "In May last, Mr. Griffith stated that in consequence of the information which he had received from Mr. Oldham, he had caused all this strike of country to be re-examined, and presented a list of localities in which his observers traced fossils in this district."

In December last, Mr. Hugh Nevins brought forward "Some remarks upon three localities of Silurian fossils in the Co. of Waterford;" and independently of pointing out a new locality in which silurian fossils are found, and so proving the continuance of these deposits, starts the important idea, that the rocks in the immediate neighbourhood of Waterford which have hitherto proved unfossiliferous, are, geologically, above the fossiliferous rocks of the sea-coast; and if his subsequent observations lead him to confirm this idea, he will have made the first step in the division of the Irish Silurian rocks.

In the same paper Mr. Oldham described the rocks of Bray Head as being scratched and furrowed by parallel groovings or markings; but I shall reserve any observations upon these until we come to the second paper read by the same author, "Upon the more recent Geological Deposits of Ireland"—one of the most interesting and important of the papers which have engaged your attention. I shall not attempt to follow Mr. Oldham into details which render his paper so valuable, but merely state the general result he has been the first to establish—the existence of shells, characteristic of the newer Pleiocene, such as Nucula oblonga, Astarte gairensis, and some others, in the clays and gravels which occupy a position upon the flank of the Dublin mountains, at least 600 feet above the present level of the sea; he has carried the observations of the same beds across the whole island. Mr. Oldham differs from Dr. Scouler, whose opinion is, that the varied heights at which these deposits are found, prove the elevations to have been gradual and unequal in amount over the extent of surface; while Mr. Oldham thinks that an equable degree of elevation, converting the unequal surface of an ocean bed into dry land, would account for the difference of level. He also exhibited maps constructed to show the appearance of our country under different degrees of submersion; and argued in favour of the importance of studying the effects which

currents would have produced under the different relations of sea and land, which these different degrees of elevation would have occasioned. Need I point out to you the importance of Mr. Oldham's observations being followed out by the members of our Society, in every part of the country, until the great extent of blue shall have disappeared from Mr. Griffith's map, and the gravels of Ireland be divided, as the tertiary deposits of England are; exhibiting successive epochs, and giving a clue to the changes which have taken place in our island during the later Geological times. It is not impossible that we may yet be able to call in the assistance of those rules which are so valuable in determining the age of the older rocks. Every new observation appears more opposed to the idea of one great cataclysm having drifted gravel over the whole face of the country. I have long observed the gradual passage from broken up beds of stone, in the upper part of some of our limestone quarries, into the superincumbent gravel, where the broken but angular fragments of contorted strata retain somewhat of their relative position; and I know that my friend Mr. Mallet is of opinion that the Eskars and gravel beds of Ireland bear evidence not only of marine currents and tidal action, but of gradual elevation and unconformable deposition.

Mr. Murray's paper on some Timber, found at a depth of 57 feet, at Roxburgh, in the Co. of Tyrone, is naturally connected with this subject. He describes a tree, found apparently in the situation in which it grew, under yellow clay, succeeded by alternate depositions of sand, pipe-clay, strong red clay, and sandy loam, forming, as he believes, the alluvial deposit of the River Blackwater. What the time was which the accumulation of so deep a deposit required—what the reasons were for the successive changes in the nature of that deposit—how far this tree is related to the Lignites of Lough Neagh—are interesting problems; and I rejoice that the discussion which arose upon the reading of Mr. Murray's paper, appears to have revived the interest which our Associate, Mr. Whitla, once promised to take in investigating the history of that ancient forest, whose extent under the basin of our great northern lake is so little known.

The transport of gravel and large boulders, and the scratches and furrows which have been observed in so many parts of Ireland, whenever the removal of the soil uncovers the rock which its growth had protected from the effects of the elements, and more particularly the observations of Mr. Oldham, before alluded to, naturally lead me to say a few words on the subject of Glaciers, to which you are all aware that much importance has been lately attached, as affording some clue to the mode in which great masses of rock have been transported to great distances from their original sites. Of their agency as carriers we can have no doubt; of the extent to which that agency was applied, and of the laws which govern the

motion of these great masses of ice we have not yet had any definition so clear as to be indisputable, *et adhuc sub judice lis est.*

Confining my observations as I have done, as far as possible, to those portions of the science in which I had to comment upon the past exertions, or suggest future work to the members of our Society, I should have avoided entering upon any reference to the controversy going on, had I not felt myself called upon to vindicate to our Journal, and to one of our most valuable contributors, the credit of having been the first to press on British Geologists the importance of considering Glaciers in a Geological point of view, and propound a theory, to which probability is added, by the failure of those which have been subsequently advanced in meeting all the difficulties of the case.

These theories may be divided into three—

1st. Saussure's, or the Gravitation Theory, by which the Glacier continually added to from above, is supposed to be pressed down by its own weight along the gradual slope of the valley, being freed from its attachment to the rock, and assisted in its downward course by the lubricating effect of water brought by infiltration from above, and the gradual melting of the under surface, occasioned by the greater heat of the earth upon which it rests.

2nd. Charpentier's, or the theory of dilatation, in which the alternate contraction and expansion of the water which fills the interstices of the many-fissured mass, according as it is frozen or dissolved by a change of temperature, is supposed to produce a force by which the Glacier is moved onwards in the channel of least resistance, or down the slope of the valley.

3rd. Professor Forbes's, or the theory of viscidity, by which it is supposed that a Glacier is an imperfect fluid or viscous body, which is urged down slopes of a certain inclination, by the mutual pressure of its parts, obeying the laws of gravitation.

The controversy seems now to be between Mr. Hopkins (whose experiments seem to him to explain away certain difficulties which stood in the way of the gravitation theory) and Professor Forbes. I regret that my attendance upon the Geological section, at the last meeting of the British Association, prevented me from hearing the long discussion on this subject which took place between these able authors, especially as the imperfect manner in which the proceedings are reported has the effect of leaving the members of each section utterly in the dark as to what has passed in the others, until a year has passed over; but I understood from those who were present, that the "questio vexata" remained at the close in pretty nearly the same position it occupied at the beginning, each author adhering to his own view.

The first notice which Mr. Mallet brought forward of his views was at the meeting of the British Association, at Liverpool, where it was evident that British Geologists knew very little on the subject,

saw little interest in the inquiry, and no direct bearing upon Geology. A fuller account of these views was read by Mr. Mallet in this Society, and published in our Journal for 1838. Of this paper the only notice I find in English authors is where Professor Forbes alludes in a short note, p. 34, to an expression made use of by Saussure, "ces masses glacèes entrainées par la pente du fond sur lequel elles reposent, degageès par les eaux de la liaison quelles pouraint contracter avec ce même foud, *soulevéés meme quelquefois par les eaux* doivent peu-à-peu glisser et descendre suivant la pente des valleés," &c. and in a note upon the expression, "*soulevèés même quelque fois par les eaux*," says, "this singular expression seems to point to a cause of motion like that developed in a curious paper on Glaciers, published by Mr. Robert Mallet, at Dublin, in 1838." The passage from Saussure had been quoted by Mr. Mallet in his paper, but it is evident from the ambiguity of this one expression in the whole work, conveying rather the idea of a body floated off, and the little notice taken of it by Professor Forbes, that he rather passed it by as unworthy of much consideration, than with any feeling from which could be argued a want of candour towards a previous author; so that if Mr. Mallet's theory should eventually be proved correct, he will be entitled to the credit of first putting it forward into a place of due importance. It seems to me that Professor Forbes concludes the mass of ice to be a semi-fluid body, only from the disposition which its parts assume when acted upon by unequally retarding or onward pressing forces. But the terms liquid and viscous are merely relative; and it may be doubted whether the fissured and shattered Glacier has not the power of adapting that union of fragments (as minute in reference to a mass whose measure is miles, as the grains of plaster in Mr. Forbes' experiment were to a mass whose measure was inches) to overcome obstacles, and obey the laws of gravitation as freely as if the ice was of a viscous consistency. But even vicosity would not account for the Glacier being carried out of hollows and over heights in the surface down which it travels, and to this point Mr. Mallet has directed the influence of hydrostatic pressure, by which the water, communicating through the fissures in the ice, and multiplying its force by the surface of the water confined in its hollows, acquires a power of upward pressure, equal to the difference in weight of equal columns of ice and water, and lifts the overlying mass across the obstacles. I think it most likely that future observations will tend rather to give a value to each of these theories, as explaining causes concurrent to one effect, than the substitution of one for the other; but I see nothing that has been as yet brought forward to invalidate the conclusion of our fellow-associate, Mr. Mallet. But to return to the consideration of that part of the Glacier theory which applies immediately to the transport of boulders: Mons. Agassiz, who adopted the theory of Charpentier, and in studying the Glaciers became familiar with their abrading

and transporting character, attempted to account for the carriage of boulders, and the wearing away of rocks over a whole continent by supposing that at some past time, not only glaciers in the valleys, but sheets of ice over the plains, had ground the rocks, and shifted the gravels over the whole of northern Europe. But here again was another instance of a tendency to run riot and fall into the sophism, "a dicto secundum quid ad dictum universaliter."

The transporting power of Glaciers is evident; it is also evident that floating masses of ice do carry rocks to great distances, and that the grounding upon a shallow must produce a furrowing of the surface exposed to that rude touch; but other observations show that moving masses of gravel also leave traces of wearing and scratching upon the rock over which it moves. Mr. Lyell in his recent tour in the United States, found the same scratching of the surface of rock lying underneath the tertiary gravels of these great plains, as Mr. Mallet pointed out to you, under the gravel beds, cut through in the workings of the Drogheda Railway. Shall we apply any one of these solutions to every difficulty which we meet with? certainly not. We must accurately study the phenomena we see before us, and refer by analogy to the causes which produce similar phenomena at the present day. Analogy is the only guide we have in passing from the known and seen to the unknown and unseen. But analogy must be rigidly tested, and we must not be contented until we have accurately examined all the circumstances under which each accumulation of detritus or transported gravel has taken place. Here we have a wide field for research, which I hope every member will assist in rendering as full and as widely extended as possible.

You have had two papers upon the subject of Mineralogy; one by Dr. Apjohn, on his analysis of a new mineral, allied to Mesolite, and for which he proposes the name of Mesolitine; it was found at Newtown Crumlin, in the Co. of Antrim: another by Dr. Kane, giving an account of analyses made by him of the iron stones found in the Irish Coal districts, from which he draws the important result that the ores of the Leinster and Connaught coal fields are equal, and even, on an average, superior to those generally employed in Great Britain. To Dr. Kane both this Society and the country are greatly indebted, for the singleness of purpose with which he directs the investigation of science ever towards the development of Ireland's Industrial Resources. On the same evening Mr. Ball brought forward a notice of skulls and bones of oxen, (of a species distinct from those now existing in the country) found in our bogs. It is pleasant for us thus to see both the Chemist and the Naturalist uniting to assist in the progress of Geology.

In November last, Mr. Oldham laid before you the result of eleven months' careful observations of thermometers, placed in the Knockmahon mines, and registered under the zealous care of Mr. Petherick,

one of our associates, who is Agent to the Mining Company. The general result of these observations was, that at a depth of 774 feet there was an increase of 7° 34. above the mean annual temperature of the surface. If from this 774 feet we deduct 100 feet to get the line of no variation, we have 7° 34. for 674 feet, or an increase of 1° for 91, 82 feet; or if, owing to the locality of the mine we take the sea level as the surface, we shall have the depth equal to 600 feet below the line of no variation, which gives an increase of 1° for 81. 74 feet. This is a much slower rate of increase than any hitherto observed; and to this long series of observations we are indebted also for the interesting result that there was a gradual but definite diminution of temperature from beginning to end. In the discussion which followed the reading of this paper, Dr. Apjohn suggested an important correction which I believe has not been before noticed as an element in such calculations, namely, the increase of heat which would be due to the increased pressure of the atmosphere at such a depth below the surface; and Mr. Mallet pointed out the still further modifications which this correction should undergo, in consequence of the rapid passage of air through the mine, descending, traversing, and ascending again, and at every part of its transit engaged in establishing an equilibrium of heat with the rock with it touches. When we add to these corrections our knowledge that chemical changes often take place in rocks to such a degree as even sometimes to produce spontaneous combustion, we shall, without undervaluing the importance of such observations as those brought forward by Mr. Oldham, require that they should be often repeated in widely different localities, and in various strata, and with a due regard to all the corrections which may be required, before we allow them to stand as proofs of central heat, and of the gradual cooling of the earth's surface.

Having now considered those papers which bear a direct reference to the science of Geology, and to the history of rocks themselves, I have great pleasure in turning to those where they are considered as subservient to the uses of man; and I am sure you all feel the admiration that I do, of that zeal and ability with which Mr. Wilkinson, until within a few years a stranger to our country, and since his residence in it, engaged professionally in the laborious and thankless task of one employed to execute a great work under the control of parties having separate and conflicting interests, has accumulated a mass of the most valuable information with respect to the minerals of this country, part of which he has already communicated to you, and part of which I know that he has in store for our future meetings, independently of that contained in a work by him on the "Practical Geology and Ancient Architecture of Ireland, which has just issued from the press, and which I can merely notice thus, as I have not yet had time to give to it that attention which I feel sure that it will richly deserve. If his zeal and energy were imitated by the Civil

Engineers who are scattered over Ireland, the objects of this society would be more rapidly attained. I must refer you to Mr. Wilkinson's paper, and to the specimens which he laid before you, for a detail of the different varieties of marble, and the localities in which they are found, well worthy of your attention. In the discussion which followed the reading of Mr. Wilkinson's paper, two points require notice—Mr. Griffith admitted, that the place which he had in the railway report assigned to the black marbles of Ireland was not the true one, and that instead of occupying the lowest place in the limestone series, immediately above the yellow sandstone, they are to be found at the base of the upper limestone; he also admitted that his subdivision of the great limestone system of Ireland into three sections the lower, calp, and upper, was not borne out by his subsequent examination of the fossils, and could only be looked upon as a matter of geographical convenience and not of geological subdivision.

I cannot dismiss the subject of the economic uses to which Geology applies, without alluding to its importance with respect to agriculture. Brilliant as is the light which has been thrown by chemistry upon the relation between plants and the food of plants, eagerly as the farmer has caught at the laws revealed in the laboratory, and imagined that he had only, with a balance in his hand, to measure out to each plant the compliment of its constituents, and calculate surely upon the increase of his cereal possessions, we must not deceive ourselves; science can never take the place of experience—those who have penetrated most deeply into the sanctuary of truth are the keenest to feel the obscuring effect of the mists which surround their path: and while we find chemists differing among themselves as to whether plants have a power of substituting one principle for another, or of throwing out some of their ordinary constituents without injury to health and growth; whether they have, like animals, a power of absorption and secretion, or only of selecting their proper food; to what extent they decompose mineral compounds, and whether they absorb nitrogen from the atmosphere as well as from the soil, we can only look upon chemistry as the most valuable assistant in guiding us to experiment; but, on the other hand, we must not undervalue that guidance, but carry a knowledge of the constituents of the soil we till, and the plants we tend, into every effort at agricultural improvement. Now the study of Geology will enable the farmer not only to follow out the source of springs, and suggest the easiest channels for drainage, by rendering him acquainted with the position and nature of those strata through which water percolates most freely, but it introduces him through the outward character of minerals to a knowledge of their inner formation and constituents; by a shorter, and, to him, a more accessible path than that of chemical analysis—the external appearance of the rock points out to him at

once the result of laborious chemical investigation, and enables him to apply practically the discoveries of science. And here I must point with pleasure to a work, the tendency of which is to smooth down the difficulties of studying the simple minerals: hitherto the arrangement adopted by modern writers on mineralogy has been strictly chemical; their classification was grounded upon an index of analysis, and a beginner was required to know the constituents of a mineral before he could find its place in the arrangement. M. Dufresnoy has, this year, published the first part of a work upon mineralogy, which appears to me admirably calculated to remove this difficulty from the path of the student; he has adopted the dichotomic method of Lamarck, in which every step in our identification of a mineral rests upon the choice between two well defined and opposite characters; and we are easily led to a place in a more scientific arrangement, in which the mineral may be found, and our identification tested, by the more accurate description of the analyst.

The connection between the vegetable inhabitants of a district and its rocks is too well known for me to illustrate it by many instances, but I shall refer to two as examples: the extraordinary fertility of that vein of country which stretches from Limerick to Charleville, and has been called the Golden Vale, is well known; the lands surrounding Croghan Hill, in the King's County, are also celebrated for an inexhaustible freshness, which impresses a value upon them far exceeding that of the surrounding plain. The character and position of the rocks of both districts I have shown to be similar, and I have no doubt that an analysis of the rock, and of the rich brown soil that results from its disintegration, would well repay the labour of a chemist. Again, another appearance has often forcibly arrested my attention; I have scarcely ever seen a hill covered with stunted hazle coppice that I have not found the rock to consist of that splintery limestone, which abounds in chert nodules; here there must be a connection between cause and effect; and the growth of plants, upon which man's comfort more immediately depends, are, doubtless, equally dependent upon local circumstances. Engaged, as I am frequently, in valuing land, I find it impossible to arrive at a right conclusion without taking Geological circumstances into consideration. I have generally found an accurate coincidence between the boundaries of distinct qualities of land and geological circumstances, but their relations are much more complex than might at first appear; the soil does not always result from the disintegration of the subjacent rock, and the washing from an aluminous shale will injure the fertility of a limestone plain, while the debris of a mountain, richer in fertilising compounds, will amend a district of less genial nature; a soil containing all the elements of fertility will be rendered barren by the stagnation of water, where the substrata offer no facility for natural drainage; but here art supplies the defect of nature, and

the skilful agriculturist will be led, by following the outcrop and succession of rocks, to the readiest mode of cutting off the injurious source of subterranean springs, and directing surface water into the nearest and freest channels of escape.

I now conclude my feeble sketch of the subjects of deep interest, which have occupied your attention during the past year—may I hope that in this coming year we may be allowed yet further to unroll the great history of creation, and those secondary laws by which the power of the Creator is felt in all its attributes pervading the universe. It is easy to urge the importance of Geology as a science upon those who have once dipped their lips in the fountains of truth, and acquired that thirst which no other draught can satisfy. But even if we turn to those who see no charm in learning, unassociated with immediate and evident increase of wealth, have we not abundant inducement to offer to them? When we see the flourishing condition of our mining companies, and the value of our mining produce; when we read of materials exported from the quarries of Valentia being employed in the construction of that noble edifice which Great Britain is raising to concentrate the beauty and richness of her ancient architecture, and to be a fit hall for the meeting of our Queen and her people; when we see the serpentines of Connemara vying in beauty with the Verdantique, and only kept out of the market by the lord of the soil's mistaken policy; when we see the noble columns and highly finished entablatures worked out of the quarries of Tullamore, Ardbraccan, or Ross, and know that it is the sharp chisellings of that stone which yet remain in the ruined abbeys of Ireland, as fresh under our humid sky as if they had stood in the dry atmosphere of Egypt or Syria, may we not tell them that the rocks of Ireland are becoming a source of increasing wealth and domestic prosperity? When we see the most enlightened states of Europe and America making provision for the pursuit of geological research; when we see our own government associating Lyell and Faraday, Cubitt and De La Beche, in commissions, for investigating the cause of great catastrophies, such as the fall of the mill at Oldham, and the fatal explosion in Haswell colliery; and when we hear these philosophers urging upon our rulers the importance of instructing even the working classes, in the principles of Geology, may we not tell them that in undervaluing that science they are retarding the progress of civilisation? and when the wealthy refuse their aid may we not tell them that they do so with prejudice to their own interest, in the increase of that wealth?

And now let me express my thanks for the honor you have done me in again placing me in this chair, which I would willingly see occupied by one who had more time to devote to the objects of the Society, and more influence in promoting its welfare; and, let me hope, that as our numbers increase, our strength may be added to by

those who can bring high talent to bear upon the difficulties that come before us; that cur discussions may be conducted in a spirit of candour and good feeling; our only object truth; our motto, "forward, ever forward"; and that many may, as I do, look back upon these meetings as a source of acquaintance and friendship, of enjoyment as well as profit.

THE END.

JOURNAL

OF THE

GEOLOGICAL SOCIETY OF DUBLIN.

VOL. III. PART II. 1845. No. 2.

March 12th, 1845.—Sir H. T. De La Beche, Director of the Geological Survey of Great Britain; Wm. Fraser, Esq. C.E. Office of Public Works, Dublin; and G. J. Allman, M.B. Professor of Botany. T.C.D. were admitted Members of the Society.

A paper "On the composition of certain Zeolitic Minerals," by James Apjohn, M.D. &c. &c. was read.

In this paper the author gave the results of his analyses of several Zeolitic minerals, from the north of Ireland, some of which appeared to be undescribed.

1. Verrucite.

This name was given from the warty appearance which the mineral presents. It is of a reddish brown colour, in rounded globules, or warty aggregated lumps, and exhibits when fractured a compact structure entirely destitute of crystalline character.

Sp. gr. 2. 339.

Its constituents are—

Silex,	43.61
Alumina,	24.65
Per-oxide of Iron,	0.68
Lime,	12.39
Magnesia,	0.68
Soda,	5.89
Water,	11.78
Loss,	0.32
	100.00

The formula is therefore

$$2\,(Na\,O,\ Si\,O_3) + 5\,(Ca\,O,\ Si\,O_3) + 5\ Al_2\,O_3,\ 3\ Si\,O_3 + 14\ HO.$$

or more probably

$$\overline{2(Na\,O,\ Si\,O_3) + 2Al_2\,O_3, Si\,O_3, + 2H\,O +}$$
$$5\,(Ca\,O, Si\,O_3) + 3\,Al_2\,O_3, 2\,Si\,O_3 + 12\,H\,O$$

L

It occurs in the porphyry district of Sandy Braes, at Tardree Hill, at Magilligan, and other places in the trap district of Antrim.

2. Parastilbite.

This mineral is noticed in the Ordnance Geological Report on Londonderry, &c. by Captain Portlock, and the results of an analysis of it, executed by Dr. Thomson of Glasgow, are given in page 744 of that work. These results are, however, very different from the following, obtained by Dr. Apjohn.

Silex, ...	58.27
Alumina, ...	17.55
Lime and trace of Magnesia, ...	9.76
Water, ...	15.28
	100.86

corresponding to the following formula:—

$$3\,CaO,\,2\,SiO_3 + 3\,(Al_2O_3\,3\,SiO_3) + 15\,HO$$

It is not a Laumonite, as it contains less Alumina and Lime, and 10 per cent. more Silex. Nor yet is it a Stilbite, as conjectured; but it certainly approximates to this mineral in composition, and would be identical with it, if it contained $\frac{1}{11}$ more silex, and $\frac{1}{5}$ more water. As another distinction between this mineral and Stilbite, it may be mentioned, that while the latter (Desmine of Rose) occurs in the Right prismatic system, the crystal of the former is distinctly an oblique Rhombic Prism. From its resemblance and approximation to Stilbite in composition, it has been called Parastilbite.

It is found coating the fissures of the slates near their junction with the Granite of the Mourne Mountains, near Kilkeel, Co. Down.

3. The last mineral subjected to analysis, was given to me by our Assistant Secretary, Mr. Oldham, (as were also the other specimens) as a specimen of the Lehuntite of Thomson. It is white, has a close crystalline structure, and is difficult to break.

Sp; gr:. 2.046.

Silex, ...	47.61
Alumina, ...	26.82
Lime and a trace of Magnesia, ..	1.08
Soda, ...	12.75
Water, ...	9.87
Loss, ...	1.87
	100.00

corresponding to the following formula:—

$$NaO,\,SiO_3 + Al_2O_3,\,SiO_3 + 2\,HO$$

There can be no doubt, therefore, that Lehuntite is not a distinct species, but only a very slightly modified form of Natrolite, as Mr. Oldham has already stated. The specimen analyzed was identified by Dr. Thomson himself as his Lehuntite.

April 9th, 1845.—A paper "On the Plasticity of Glacier Ice, by Robert Mallet, Esq. M.R.I.A. &c. Secretary of the Society, was read.

In the course of the discussion upon the mechanism and conditions of motion of glaciers, which has continued since the publication of Professor Forbes' first papers on the subject, very much stress has been laid by most authors, and especially by Professor Forbes himself, on what he has called the plasticity of the glacier ice. Indeed, so important a part does this assumed property play in his views, that he almost appears to rest his claims to discovery, or at least to enunciate his discovery, of the nature of glacier motions, in the assertion of this plasticity of mass. A great deal of controversy has been wasted respecting this assumed property from the want of forming distinct ideas as to what this quality in question really is; and having fixed its conditions, determining whether such were compatible with the known properties of ice. Nor have the verbal definitions of Dr. Whewell, recently published in the "Philosophical Magazine," at all helped the matter. It is not my present object to enter upon the question of glacier motion generally. I have for some years abstained from joining in the controversy which I was the first British author to raise, confident that, ultimately, the views I originally promulgated as to the great motion of translation of glaciers would be acknowledged in the main as true; and having already seen one opposing theory, that of Charpentier and Agassiz, consigned to merited oblivion, after having been carried away by all British Geologists, I have little doubt of yet seeing the same fate await the plasticity theory.

In saying this, I beg not to be understood as slighting the undoubted merits of Professor Forbes, who has been the first to demonstrate, by well devised measures and experiments, the actual motion of the glacier, but who has not, that I can perceive, thrown any fresh light upon the causes of these motions, by the assertion of an ill defined plasticity in the mass of ice, and its illustration, in common with Professor Gordon and others, by small experiments upon pitch and other admittedly plastic bodies, whose molecular properties are totally distinct from those of ice in any known state.

My present intention is merely to call the attention of those interested in these questions to certain ascertained facts as to the molecular constitution of bodies, which appear to me to preclude the possibility of such a property as plasticity existing in ice; and thence to show that the power of moulding its mighty mass to the sinuous and unequal, or occasionally narrowed and wire-drawn portions of the glacier bed, is due not to any such imaginary property, but simply to the breaking up of the rigid mass, and its continual subdivision by the various forces to which it is exposed.

And first, by plasticity is meant, I presume, *the intermobility of*

particles, without discontinuity, of a body beyond the range of its elasticity. The extreme case of this is fluidity. This property may be accompanied with great elasticity and elastic range, or these additional properties may be wholly wanting. Indian rubber is an example of the first, tempered clay of the second.

Now, I assert that no known case can be quoted of a crystallised body possessing these properties. The very essential idea of crystallization is mutual, rigid, fixation of particles, except within the elastic range, upon which the external form of any individual crystal depends, and which, break it up as you will, causes every fragment to be of the form of the original, or derived from it. A single crystal, or a crystalline mass, may, by the application of external force, be bent or twisted, or compressed, within certain limits due to its particular elastic modulus, but increase the force beyond these limits, and rupture or fracture instantly takes place. This is as true of the most imperfectly crystallized bodies as of those most perfectly so. Thus a plume of amianthus, or a plate of mica or selenite, may be bent almost double, or a plate of elastic marble may suffer a large amount of flexure; but increase this beyond a given point, and fracture results. So in the metals which are so imperfectly crystallized; a load which produces a "permanent set," as it is called by mechanics, produces incipient rupture; for flexure continues and increases until at last the bar breaks, and in general, the more perfect the crystallization of any body is, whether metallic, saline, or simple, the more brittle it is, however great its modulus of cohesion, and irrespective thereof.

I affirm, therefore, that if glacier ice possess a crystalline structure, it is impossible for it to possess any plasticity whatever; and that it does possess a crystalline structure, optical phenomena prove, as well as those presented by the decomposition of glacier and iceberg ice. Indeed it scarcely admits of a donbt, that ice is not capable of existing in any other than a crystallized form. I am not aware of any instance that can be given of any solid body composed of two elements, one or both of which are non-metallic, and where the atomic constitution is in the same ratio as that of water having any other structure.

But with respect to ice, Dr. Brewster has proved it to have a crystalline structure, in plates as removed from the surface of frozen water; we see it shoot into crystals upon a freezing pool; it forms in crystals as hoar frost, and we see it fall in crystals as snow; and the mass of the glacier is made up of snow crystals cemented into a mass by freezing together; and are we to suppose that in this act of consolidation, these minute snow crystals do not continue, and impart their own crystalline forms to the water frozen between them; but, contrary to all analogy, assume them to lose their own crystalline structure, without being liquified, and not

aggregate to themselves fresh matter of their own kind to fill with crystals similar to themselves the interspaces between them?

I conceive that what I have thus briefly and imperfectly stated, destroys the possibility of assuming glacier ice to possess plasticity of any kind, without violation of all sound reasoning upon the known molecular properties of ice and all other crystallized bodies.

Nor is it necessary to call in the aid of such a baseless hypothesis to account for the most extreme and distorted cases of glacier motion. Sufficient subdivision of the whole mass, to give enough of intermobility to its integrant masses, is all that is requisite to enable the enormous procession of colossal fragments to be pushed, or slide, or stagger, or be lifted through the narrowest gorge of the glacier valley.

Enormous as is the magnitude of each block of ice between the crevasses of any given locality, it is a small piece compared with the whole moving mass, with the forces engaged, and with the cavity in which it moves: and thus the congregation of these huge and rigid blocks moves forward, and adapts itself more or less completely to the twistings and changes of size and shape of the glacier valley, with much of the outward character of a fluid or plastic mass. But there is no more real plasticity than there is in a cartload of road metal when shot from the cart; which, notwithstanding the rigidity of every broken angular stone, assumes the general character and outline which a mass of plastic mud would, if shot from the same cart.

This power, then, of adapting itself to its bed, viz., by being broken up into fragments of such a size as to be small in proportion to the whole mass and to the cavity in which it moves, it is due to myself to remark that I clearly perceived, and have distinctly enunciated in my original paper on the "Mechanism of Glaciers," published in the Transactions of this Society, in 1838. The passage will be found in pages 10 and 11 of the paper, which having been published fully nowhere else, and that Journal having only a limited circulation, has, I am aware, become little known.

It appears strange how Professor Forbes after remarking upon the annual reappearance of the same crevasses in the same spots of the glacier, should have conceived any such theory as plasticity necessary to account for the motion of translation; and equally strange does it appear how obstinately both he and Mr. Hopkins reject the idea of any essential aid being had from the lifting of the masses by hydrostatic pressure, although both admitting, I believe, that there may be, and most probably are great cavities in the bottom of glaciers—valleys by which the ice becomes hooked on to its bed—and from which neither of these gentlemen's views seem capable of detaching it without the aid of this, which I believe to be not the

sole, but one of the most important causes of the motion of the translation of glaciers.

It is quite true, as has been said by Professor Forbes and others, that Saussure noticed this cause of motion. So he did, incidentally; in one single sentence in his three quarto volumes; but it is perfectly clear that Saussure looked upon the lifting of the ice by hydrostatic pressure solely as a possible and contingent event, and not as an efficient cause of glacier motion in daily and hourly action.

While, on reviewing my paper of 1838, I can now mark some mistakes, and see that I, perhaps, attached an undue importance to some minor phenomena (an error into which those who, like myself, have no opportunity of obtaining measures of the phenomena, which they wish to explain, are prone to fall,) I am, nevertheless impressed with the belief that the main views I then enunciated as to glacier motion, are true; they appear to be supported by Mr. Hopkins' researches, and I am not aware that they conflict with any truth that Mr. Forbes has advanced. To the latter philosopher will ever belong the merit and the good fortune of having been enabled first to apply accurate measures to glacier motion, and by fixing our data, and removing a mass of rubbish, done more than any living man to advance our knowledge of this subject.

May 13th—P. Fenlon, Esq. Mining Agent, Coalbrook Colliery, Co. Tipperary, was elected a Member of the Society.

A paper, entitled, "Additional Remarks on the Plasticity of Glacier Ice, being a note to the preceding paper, by Robert Mallet, Esq. M.R.I.A. &c. &c. was read.

Since the preceding paper was written and read, it has been urged as a forcible argument against the views I therein put forward, as to the impossibility of plasticity existing in a crystallized mass—that the mass of glacier ice may be viewed as a sort of crystallized sponge, penetrated by water held between its interstices in all directions and at all depths; and that although a perfectly crystallized mass cannot also be plastic, such a compound structure may admit of plasticity.

It is extremely difficult to gather from Professor Forbes' book what view he has formed, or whether he has formed any precise view as to the molecular structure of glacier ice; or what is the precise meaning he attaches to the word, "granules," which, in p. 160, he applies to particles of snow; and again, in p. 174, uses apparently to signify the separate little masses into which the minute fissures divide the superficial ice. "Granule," applied to snow, I suppose to be only a loose term for a small crystal or congeries of crystals—applied to the small masses of compact ice, separated by capillary fissures, it certainly suggests an erroneous

conception. That compact "Blue Ice" is crystallized, Professor Forbes admits as a general fact, in p. 160. That his "snowy granules" are crystals, will, I presume, not admit of dispute; and these are the elementary fragments out of which the compact ice has been formed by the imbibition of water. The only question, therefore, is whether, in some intermediate state, the great mass of the glacier exists as a huge dripping, unconsolidated icy sponge.

Upon this objection to my views I would remark, that it is mere matter of assumption that the mass of glacier ice is throughout penetrated in any such way by watery spaces. Hand specimens shew nothing of the sort at whatever depth taken. Nor have the experiments made as to capillary fissures at all proved either their universality as to depth, or even surface, much less their size being sufficient to permit plastic motion.

It seems a very general and sweeping conclusion, indeed, from most narrow premises, when, in p. 175, Professor Forbes having recorded his single experiment of pouring colouring matter into a hole, *a foot square*, on the surface of the ice, and having found after some hours, that "though much of it remained, much was effectually and visibly infiltrated into the ice beneath and around," at once "freely admits"—freely indeed—what he formerly doubted, that a glacier in summer is penetrated to a great depth with water, which saturates ALL its pores. In fact it has never yet been proved that there are any pores or fissures in the mass of the compact glacier ice at all, except within a few feet of surfaces, whether horizontal or vertical, which have been for some time exposed to changes of atmospheric temperature, from the disintegrating effects of which, I believe, these superficial fissures arise, and are peculiarly analogous to those which render brittle, and disconnect a thawing iceberg.

Indeed some facts stated by M. Desor, in a letter to M. Elie de Beaumont, published in the Comptes Rendu, for December, 1844, seem to settle the question of fluid water existing in the interior of the glacier masses at all, for he found, on withdrawing the self-registering thermometers, sunk by Agassis at only five metres depth in the ice, that the corrected temperature was — 2·1 centigrade—so that the internal temperature, even thus close to the surface, is considerably below the freezing point, and the ice at the spot was clothed with a metre and a half of snow above its surface. Furthermore, M. Dollfuss has proved, that the lower down the line of glacier we go, the greater is the density of the ice, that is to say, the more compact is its structure, and the more perfect its crystallization; whereas, if it were the dripping, loose, sponge that the plasticity theory requires, it must become more and more loose the longer it is exposed to percolation, and the warmer the region into which it travels. This theory, therefore, sets out with the assumption of, at least, two pure hypotheses—1st, that the whole mass of ice is throughout fissured; 2nd, that being so, the conditions permit these

fissures to remain permanently filled with unfrozen water; and granting these conditions, it is equally an assumption, that any thing like plasticity would be conferred by them.

Thawing ice has never been found under other circumstances, in any analogous state; on the contrary it is well known, that when floating icebergs descend into southern latitudes, and are in a thawing condition, in place of being plastic, they are throughout their whole masses, so pre-eminently brittle, that the firing of a gun is often sufficient totally to dislocate and shatter their scarcely coherent crystals. Nor does the unsound and *slushy* surface ice, found in our own, or in arctic climates, when in a thawing condition, and greatly penetrated with water, present any trace of plasticity.

Again, it is confessed on all hands, that the whole glacier mass must be viewed as full of dislocations, and that the great fragments are more or less insulated masses. These are often one hundred, or even five hundred feet in depth; is it then conceivable that if such masses were really plastic, they should show their plasticity only in the direction of horizontal or inclined motion? Rather is it not certain, that they would be pressed down, more or less, under their own enormous weight—that their sides, where free, would bulge outward, filling up the crevasses between, and presenting to the eye all the outline of plastic masses, in place of the keen, cutting, cliff-like, and often overhanging sides which these invariably show.

The argument with which, I presume, this would be met is, "that the glacier does fall together and choke its own crevasses with its plastic substance," (Forbes, p. 173, 367.) From this I beg to dissent. If the substance were plastic there *could* be no crevasses formed, or if formed, they must *immediately* be choked up, or show a tendency to choke up, by the bulging inwards or together of their walls; but such is not the fact, either as observed, or as described by Mr. Forbes. The crevasses become choked gradually and imperfectly during the heat of summer, and when the whole motion is a maximum: first, by the mutual squeezing together of the separate masses as they stagger onwards; and secondly, by the effects of thawing, by the falling in of masses from their edges, owing to their very *brittleness* and dislocation, produced by change of temperature in their crystalline blocks.

I venture to propose an experiment to those who have opportunity of investigating the subject, which will set at rest the question of an universally pervading fissured and watery structure. Let a suitable compact block from the middle region or any where, (excepting close up to the neve) of large dimensions, be chosen; work a jumper hole into it, to a depth of fifty feet or more, and split it by a blast of gunpowder, and examine the structureof the interior ice, thus suddenly exposed, I will venture to express my belief, that it will be found compact, and free from watery fissures, penetrating its substance in all directions.

It does appear singular to me how one of Professor Forbes' great perspicacity can lay any stress, or ground any argument upon such experiments "en petit," as he and others have made on plaster, pitch, &c. in artificial troughs of a few inches or feet in length. These bodies are *confessedly plastic*, while it remains to be shown that ice is, and all these experiments, which thus set out with a "petitio principii," only prove (if they prove any thing) that it is possible to simulate, and represent in some degree to the eye, the general form and motion of a glacier, by that of a small plastic body; but this is only to show, in one particular instance, that all bodies which flow, viz. which move in a continuous train or stream, no matter how, do present certain characters in common. This is true of a cart-load of broken stone or road metal when shot out, or of the mountain of shattered rock strewn at the foot of a mural precipice, as much as of a mass of plastic mud. In a word, such experiments *are illustrations*, in which there may be accidental and superficial resemblances, and these even very exact, but in which the conditions are so entirely different that there is *no analogy*, and therefore no base for argument.

If an advocate of the plasticity theory will crystallize a mass of soda or of alum, or some other cheap salt, in a form to be interpenetrated with water, or with water and foreign matter, as clay, sand, &c. which can easily be done, and show that this mass, in pieces of a few feet in length, even, has any traces of plasticity, the experiment would bear more upon the question. It would remain, however, to show that glacier ice was in an analogous condition.

In conclusion, I cannot help remarking two instances of approximation to my previously enunciated views in the most recent papers of Professor Forbes and Mr. Hopkins, which I have seen in the Phil. Mag. for this month, and in Jameson's Journal, last number.

In treating of the motion of the translation of secondary glaciers, Professor Forbes for the first time admits hydrostatic pressure to a prominent place as a cause of their motion, or rather the want of it, by want of water, as the cause of their slow motion. While Mr. Hopkins urges in a forcible manner, the internal freedom of motion of the whole glacier mass as due to the dislocation of its parts, and the reproduction of crevasses.

It seems to me that much light might possibly be thrown upon the subject of the coloured bands of glacier ice, (which I am strongly impressed have a crystalline origin) by experiments made on a large scale, with such masses of crystallized salts, as I have above alluded to, subjected for some time to alterations of temperature, pressure, &c.

My belief has always been, that this ribboned structure, or structural banding, is in fact due to the subglacial streams acting as a source of warmth, and producing some crystalline change in the

mass, perpendicular to this source of heat, in the way to be noticed further on.

Now I admit that it is conceivable, that if these bands indicate lines of crystalline separation, there may possibly be some sliding past each other of the plates, indicated by the bands, and possibly even without absolute discontinuity; but of all this there is not a vestige of proof, on the contrary, such a conception seems unsupported by every known fact as to the molecular arrangements of crystallized bodies. I myself long ago insisted that the middle portions of ice moved much faster than the sides; and Professor Forbes has measured an amount of difference which appears to be as 13 : 1 in some cases; but we have no proof that this difference is due to plasticity beyond his assertion. I affirm it to be due to disconnection of parts, and their relative unequal motion; and whether Professor Forbes does not mean something the same, by the phrase, that the "glacier moves as a bruised mass," I am unable to discover.

The analogy would be closer, if salts belonging to the same crystalline system as water were chosen for experiment. In a paper of mine, lately published by the Geological Society of Dublin, I have drawn attention to a fact of crystallization which seems to bear directly on this point, viz. that in all crystallized or crytallizable bodies, if they are suddenly cooled, or chilled, as it is technically called, from a state of fusion or solution, by a plane surface of low temperature, the crystals in forming arrange themselves perpendicularly to the refrigerating plane; thus, if speculum metal or cast iron, or indeed any crystallizing metal, be cast in a thick metallic mould, so as suddenly to chill them, their crystals are all found on fracture perpendicular to the faces of the mould. The same has been remarked of the crystals of trap rock in dykes, and generally of vein stones. it is also true of highly concentrated solutions of salts, which, on crystallizing, form one mass, like water freezing into ice; and conversely, if a crystallizable body be heated near to, but not up to its fusing point, by the application of heat in one plane, a crystalline structure perpendicular to the plane is immediately developed. Thus, if a cube of lead be laid on, or held against a hot plate of any substance, until it is heated to within a few degrees of fusion, it becomes brittle, not *plastic*, observe; (and indeed this is the very process used in the arts for pulverizing or granulating certain otherwise tough metals, such as some kinds of brass, by heating them slowly, until they crystallize and become brittle,) and on breaking, it is found to have a crystalline structure, the direction of the crystals being perpendicular to the heating surface; so that, in general, *change of temperature beyond certain limits developes in crystallizable bodies a crystalline structure in the direction of transmission of the wave of heat, whether into, or out of the mass of the body* This, it seems to me, will probably be ultimately found to be con-

cerned in the formation of the coloured or ribboned bands, (viz. bands of variable crystallization) in glacier ice; and if this be true, it renders the plasticity of the mass the less likely in proportion as its perfect crystallization becomes more certain.

The perfect brittleness and looseness of cohesion of crystalline bodies, when heated nearly to their melting points, as above illustrated in the case of metals, and as observed in thawing ice bergs, suggests also one circumstance of rapid degradation, and of motion of translation in glaciers which connects itself with Mr. Hopkins' views; namely, that the mass of glacier ice, at the bottom, either in contact with the glacier valley, with the subglacial streams, or hanging cavernous above them, must be in this brittle loose and dissolving condition; and hence, must crumble away under pressure from above with great rapidity, while the crystalline particles thus pulverized (so to speak) must be washed away and melted in the subglacial water; and thus, a source of very rapid descent added to all others. I know not, however, how far Mr. Hopkins may have anticipated this in his writings.

Professor Forbes attaches prime importance as proofs of plasticity, first, to the wire drawing of the ice through narrow gorges, as at the debouchure of Le Talefre; second, that if not plastic they would remain stationary, or descend in avalanches. As to the first, my views, which attached so much importance to the undermining and lifting action of the subglacial streams, seem to afford a sufficient solution of the passage through gorges. The streams are here narrowed and increased in action, and the ice is more broken up and dislocated by greater pressure, &c.; at the Talefre the extremity is a mere cataract of tumbling blocks. As to the second objection, I ask, does the sand of an hour glass descend in avalanches, (that is, per saltum?) does it not flow with the perfect uniformity necessary for a measure of time? and so also will any other mass composed of rigid, separated parts, provided these parts are small, relatively to the whole.

JUNE 11th—"Some further remarks on the more recent Geological deposits in Ireland," by Thomas Oldham, F.G.S.L. &c. Professor of Geology in the University of Dublin, were read.

In this paper the author merely added to the information contained in a paper read before the Society, in June, 1844, (an abstract of which was published in the Journal, Vol. III. Part 1, No. 3.) Since that time he had been able to trace much more satisfactorily the continuity of the deposits of gravel and clay, containing marine shells, in the vicinity of Dublin, having found them in several places, between the points before noticed. Along the coast between Balbriggan and Drogheda also, the same clays occur, containing

Nucula oblonga, &c.; but here at no great elevation above the present level of the sea.

By the kindness of Mr. Mallet he was also enabled to add the fact of the discovery of Buccinum undatum in the gravel deposits of Westmeath, near the town of Moate. This was an interesting fact, as there were few parts of the island where the features of the Eskars were better marked than here.

The author was able to add to the list of species observed in these clays near Dublin, the following, viz.—

Rostellaria pes pelicani,
Fusus antiquus,
Buccinum undatum,
Nassa incrassata,
Natica alderi,
Littorina neritoides,
Trochus umbilicatus,
,, zizyphinus,
Triquetra,
Spirorbis,
Balanus, impressions.

The Natica Alderi is interesting as being a form not now known as living in Dublin Bay; but it is found on the south coast of Ireland, and also on the west. It has also occurred in deposits of this age in Scotland, &c.

The following is therefore a complete list of the species which have been noticed in the vicinity of Dublin :—

Rostellaria pes pelicani,
Fusus antiquus,
Buccinum undatum,
Nassa incrassata,
Turritella terebra,
Littorina vulgaris, (L. littoreus,)
,, neritoides, (Nerita spiralis)
Nerita littoralis,
Trochus zizyphinus,
,, umbilicatus,
Natica alderi,
Ostrea edulis,
Pecten varius,
,, opercularis,
Nucula oblonga, (Brown)
Cardium edule,
Tellina solidula,
Cypina islandica,
Astarte Gairensis,
Pullastra decussata,
Corbula nucleus ?
Saxicava rugosa,
Dentalium entalis,
Triquetra,
Spirorbis —— ?
Balanus, impressions.

making in all twenty-six species.

The very small number of species observed, is most probably owing to the fact, that no very favourable opportunity has offered for their collection. In illustration of this, the fact of the discovery of no less than forty-five varieties in similar deposits, near Belfast, as noticed in the interesting account by Mr. Bryce, (Phil. Mag. May, 1845,) might be mentioned, peculiar facilities having arisen from the excavations in the clay.

In connexion with these deposits might be noticed the almost universal existence of parallel furrowings, scratches, and polished surfaces of the rocks below them. The author had noticed last year the existence of these at Bray Head and Killiney. He had since traced them at Howth, and here very nearly in the same direction as at Bray Head, and across, not with, the slope of the hill. They may also be seen in every place where the limestone is newly uncovered, in the neighbourhood of the city, as along the line of the Drogheda Railway, at Raheny, Malahide, &c. first noticed by Mr. Mallet, and also at Drogheda, preserving a rude approach to parallelism throughout.

Similar markings may generally be seen in the centre of the island also, wherever the surface of the limestone is freshly uncovered, but they soon disappear on exposure.

The author again solicited the aid of the members in extending the knowledge of these most interesting deposits.

A notice of the occurrence of Wood Coal near Belfast, by James M'Adam, Esq. Belfast, was read.

In the Autumn of 1837, some specimens of coal were met with in the cuttings made for the new road between Belfast and Crumlin, in the townland of Cairnaghliss, six miles from Belfast. The majority of the specimens resembled the ordinary wood coal or Lignite of the Co. of Antrim; but some were of a more compact nature, not unlike Cannel coal. It was found to give a strong heat, and the discovery having attracted the attention of several persons interested in manufactures in Belfast, arrangements were made with the proprietor for further search, which was entrusted to the superintendance of the author of this paper. A section was made at one side of the road where the coal had been first met. In this section it was found apparently interstratified with a light coloured clay, which stood the fire well. A boring was also commenced here, but the trap rocks were soon met with. At a short distance to the south east another boring was then commenced, and passed through fifteen feet of superficial clay and gravel, with occasional boulders of trap; this clay became blueish as the boring advanced, and was mixed with some coal similar to that found at the road side; this ceased at a depth of twenty-five feet; variegated

clay with occasional loose stones succeeded, and the boring soon reached the trap rocks. In the next summer (1838) the search was prosecuted, and a horizontal level driven in towards the south, and cross levels from it to the west, towards which point the Lignite appeared to dip. The thickest part of the seam was from thirty to thirty-six inches, but it varied very much, being in many places not more than a mere string, and was associated with a variegated clay, often pure white, and occasionally green and unctuous, with, in some places, a little pyrites.

Besides these openings a boring was made through the trap rock, under the vague idea that it might be of inconsiderable thickness, and cover another bed of lignite as it is found to do in other places in the same county. This boring having passed through twenty-six feet of clay, was continued for one hundred feet through the trap rock without any alteration, when it was discontinued.

The quantity of lignite is obviously very inconsiderable, and it would seem to occupy a small hollow or depression in the trap which is the surface rock of all that district.

JOURNAL

OF THE

GEOLOGICAL SOCIETY OF DUBLIN.

VOL. III. PART II. 1845. No. 3.

November 12th, 1845.—John Neville, Esq., C.E., County Surveyor for Louth, Dundalk; and C. B. Lane, Esq., Assistant Professor of Civil Engineering, T.C.D., were admitted members of the Society.

"Preliminary notice on the movements of Gravel Beds and Boulders," by Robert Mallet, Esq., Mem. Ins. C.E., M.R.I.A., &c.

The printing of this paper is postponed until it be completed.

December 10th.—R. M. Alloway, Esq., Derries, Ballybrittas, and Booterstown; and Henry Aher, Esq., C.E., Castlecomer, were admitted members of the Society.

A paper "On the rocks in the neighbourhood of Killarney, with reference to the Maps and Sections published by Mr. Griffith," by C. W. Hamilton, Esq., F.G.S., M.R.I.A., President of the Society, was read.

Before I bring under your notice some recent observations on the rocks composing the mountain-chains of Kerry, I shall recapitulate the information that we possess concerning them.

"When I went there in 1837, Mr. Griffith's map was my only guide; in it the whole of the district surrounding Killarney and the peninsula of Dingle, was coloured uniformly as the older clay slate. In that year I ventured to lay before you an outline of the geology of that district, only as a rough sketch, and as inviting attention to what appeared to me almost a terra incognita.

In that paper I represented the conglomerate of the Reeks, as of the same age as the red sandstone of Cahirconree, and as supporting a mass of siliceous flags lying conformably between it and the mountain limestone of the valley of Kenmare.

Two years subsequently, Mr. Murchison and Professor Sedgwick, having communicated a paper to the *Philosophical Magazine,* upon the carboniferous rocks of Devonshire, referring them to the carboniferous, and not the Greywacke series, added the following note as a postscript (vol. xiv. p. 517):—

"We alluded to the possibility of the Devonian, or old red system being much developed in Ireland, and under mineral characters analogous to those of Devon. In support of this view, we may add, that since this paper was printed, Mr. Charles W. Hamilton has called our attention to a paper read by him before the Geological Society of Dublin, in 1837, in which he described the rock, hitherto called Greywacke slate, which occupies a great extent in the county of Cork, as lying conformably upon the old red sandstone and conglomerate of the Gaulty mountains and the Reeks in Kerry, and supporting carboniferous limestone, into which it gradually passes."

The next notice of the district was Mr. Griffith's map, published in 1838 by the Railway Commissioners, and upon the publication of it I sent a paper to the *Philosophical Magazine,* disputing the accuracy of his map in several instances, but especially in the section from Tralee to Kenmare, in which Mr. Griffith had represented the old red sandstone, as merely a cap upon M'Gillicuddy's Reeks, and had assigned to the Cambrian epoch the mountains between them and Kenmare, which I had represented otherwise.

In the same magazine, in March, 1840, (vol. xvi. p. 164,) Mr. Griffith published a reply to this paper, in which he undertook to show that his map was correct, and that I was incorrect in every case in which I had thrown a doubt upon his accuracy. After enumerating the points of difference between us, he says (p. 163)— "that the apparent unconformability which is visible nearly in the centre of the gap between the chloritic quartz rock, and the old red sandstone, has been occasioned by a great north-west and south-east fault, which crosses the gap of Dunloe nearly at right angles, and extends from thence in a south-eastern direction along the northern declivities of the Purple, Toomie, and Glena mountains, from whence, in continuation, it reaches the lower lake of Killarney, near the Glena cottage banqueting-house; thence it crosses Brickeen Island, and passing through Turk Lake, reaches the north base of Turk Mountain.

"This fault may be said to form the key to the geology of the Killarney district, as it explains the apparent anomaly deducible from the persistent dip, to the south, of the strata on both sides of Glena Cottage and Brickeen Island, which might lead, and has led incautious observers to infer, that the strata belonging to the transition slate series, which occur to the south of the fault, rest conformably on the top of the old red sandstone of Brickeen Bridge, of the northern part of Brickeen Island, and likewise on the carboniferous limestone east of Turk Cottage."

The sections now referred to have been enlarged from the plates in the *Philosophical Magazine*, a copy of which also lies on the table. In his last map, Mr. Griffith has coloured, as Silurian, the whole of what he had previously coloured as Cambrian. Since then, the district has been visited by Mr. Murchison and Professors Sedgwick and Phillips; and in the present year, Mr. Knipe has published a geological map, in which he has coloured the whole of the rocks in question as Devonian, or old red sandstone, stating that he did so from recent observations made in 1843 by Mr. Murchison and Professor Phillips.

These are sweeping conclusions, and I rejoice to think that the detailed work of the Government Geological Survey will so soon establish the truth upon a more solid foundation; and it is this thought and hope alone that diminishes the regret I feel that I have not had the opportunity of revisiting these mountains sooner, and spending more time among them. In the few days, however, that I was able to spend there this autumn I saw enough to convince me—and, I hope, to convince you—that the view I originally took was the correct one, and Mr. Griffith's incorrect—in every particular incorrect, not only in the reasoning founded upon observations, but in the observations themselves. I shall first describe the district lying in the immediate neighbourhood of Killarney.

The Reeks, the Purple Mountain and Glena stretch from west to east, forming one great anticlinal; at the eastern extremity the elevation decreases, and the red conglomerate is succeeded by alterations of purple and greenish slates and conglomerate, which may be seen at Lady Kenmare's cottage, to the south, and O'Sullivan's Cascade, to the north; and support the limestone of Killarney, mantling round it from the Brown Island to the shores of Mucruss Lake.

The valley in which the upper lake lies, with the passage to it, and the valleys of Coomyduff and the Brown River, form one great synclinal of strata, corrugated, both on a small and on a large scale, little ridges fluting, as it were, the plain, while these folds are again elevated in contortions of a contorted rock, and form the heights of Mangerton and Torc, with the eminences, over which the road from Killarney to Kenmare passes, until they again droop to the south, support the limestone of Kenmare, and rising from beneath it on the opposite side of the valley, are found extending to the south in convolutions, where we can scarcely trace any distinction between the sections which we find at Hungry Hill and those we left at the Reeks. It is in the bare and bold escarpment of Hungry Hill that we can make the nearest estimate of the thickness disclosed; and whether we measure it there, or in the valley of Coomyduff, or in the anticlinal from Glena to Brickeen Island, we do not find a thickness above 2000 feet. My plans and sections

describe the position of these rocks to you more fully than I could do in words.*

I now return to Mr. Griffith's paper in the *Philosophical Magazine.* Fig. 1, represents a section taken in the same line as that made by me in 1837, and published in the first volume of the Journal of this society. I made another section this year from the Reeks across the valley of Coomyduff, in nearly the same place, from which you will see how completely I differ from Mr. Griffith.

I should shrink from recording such a difference in observations, were it not that I should be less ashamed of committing an error, than of proving unfaithful in reporting the appearances, otherwise than as I read them in the field. Mr. Griffith says, (p. 165,) 'You see how diametrically opposite my section is to his.' The rock is well exposed; there is no excuse for a blunder; and I freely admit that whichever of us is wrong, has failed in the attempt to observe whether a rock dips to the north or to the south.

Mr. Griffith's second section is certainly a curious one; for three-fourths of its length it is made in the exact line of the strike of the rock, in the line, which I maintain to be that of an anticlinal; and then at Brickeen, where the fault is supposed to be, the section continues at right angles to its former course, or across the line of strike.

If we turn to the map appended to this paper, (*Philosophical Magazine,* vol. xvi. plate 5,) we see the great fault, which Mr. Griffith assumes to be the key of the geology of the district, laid down, and deduced from an observation of a change in the strike of the rocks on each side of the supposed fault. Now this I could no where observe. The general lines of the strike are laid down by me upon the ordnance map, now before you, not that every observation on a district would give the same result. Where a country is fluted in one direction, and at the same time subject to elevations or depressions along the line of strike, a careless observer who took the horizontal line on each exposed surface, as indicating the strike, and marked down the dip, as being at right angles to that line, would be liable to constant perplexity and error, and such reasoning as Mr. Griffiith's might be so applied as to lead to very erroneous results; it is only by the comparison of many observations that the direction of the rock, or what is synonymous, the direction of the force that elevated or depressed that rock, can be estimated.

In a country such as that round Killarney there may be found innumerable faults and dislocations; but it is against the existence of one great upcast of 2000 feet, which Mr. Griffith contends for, as the key to the geology of the district, that I protest. I had observed a want of conformity in the rocks in the middle of the gap of Dun-

* These sections, having been given by Mr. Hamilton only as sketches, are not pnblished.

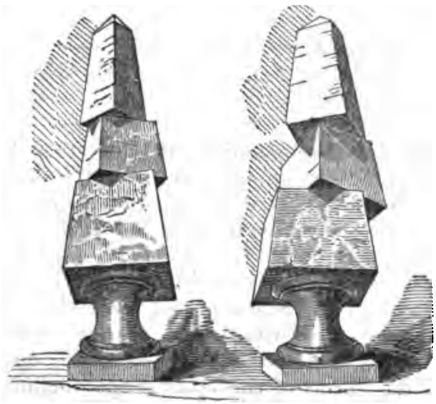
loe; whether this want of conformity is owing to a dislocation, or the circumstances under which the rocks were originally deposited, is quite a matter of minor importance: it does not affect the reasoning upon the order of superposition, and a more detailed examination will probably clear up the difficulties which must suggest themselves to any one who looks at the observations which I have again made and laid down on this map. But I think that even the contour of the hills, taken in connexion with the surrounding rocks, will point out to you that this great fault neither does nor could exist. It would be inadequate to produce the result; whereas in following out my view of the sequence, every rock seems to fall into the place it would naturally occupy, after the forcible elevation of a double mountain-chain. The very impossibility of a fault, running at right angles to the strike, having any effect on the sequence disclosed at either side of it must have led Mr. Griffith to the course adopted, and which we should not have expected from so old an observer, of running the section first along and then across the strike. The principal facts I wish now to record are, that in three sections, where I have estimated the thickness of the strata, namely, at Hungry Hill, the Reeks, and Glena, the distance of the lowest part of the red conglomerate observed from the place of the mountain limestone does not exceed about 2000 feet; and that in the absence of fossils, analogy with other districts leads us naturally to classify this deposit with the old red sandstone, or Devonian series. I have not been again able to revisit the peninsula of Dingle, and verify or disprove the truth of my former impressions; but I confess that the sweeping assignment of the whole by Mr. Griffiith to the silurian, and by Messrs. Murchison and Phillips to old red sandstone, appears to me hasty and unwarranted by sections or details; and no one, more than I, will rejoice in the result of a careful investigation of the whole of this district, under Sir H. De La Beche and Captain James, even if it should lead to my finding others right, and myself wrong."

"Explanation of the Vorticose movement, assumed to accompany Earthquakes," by Robert Mallet, Esq., C.E., M.R.I.A., Ph.D., &c. Secretary of the Society.

In our progress to the ascertainment of physical knowledge, the removal of error is next in importance to the discovery of that which is true, inasmuch as thus the road is cleared, by which the difficult journey towards truth is to be accomplished. The substitution, therefore, of a true, for a false explication of phenomena, however in themselves unimportant, is never to be neglected; and, with this view, it was that I sometime since addressed myself to the discovery of what I believe to be the true explanation of a somewhat singular, and heretofore puzzling circumstance, attendant upon the effects of earthquakes upon buildings, which has

been frequently observed, and has been hitherto explained, so far as it has been attempted to be explained at all, by the assumption of a vorticose or gyratory movement having been in some inexplicable way given to the ground. The phenomenon alluded to, is the displacement of the separate stones of pedestals or pinnacles, or of portions of masonry of buildings by the motion of earthquakes, in such a manner, that the part moved presents evidence of having been twisted in its bed round a vertical axis.

The first notice I find recorded of such a peculiar motion, is in the Philosophical Transactions, in an account of the earthquake at Boston, in New England, of November 18th, 1755, communicated by John Hyde, Esq., F.R.S. He says, "the trembling continued about two minutes; near one hundred chimneys were levelled with the roofs of the houses, and many more shattered. Some chimneys, though not thrown down, are dislocated or broken several feet from the top, and partly turned round as on a swivel. Some are shoved to one side horizontally, jutting over, and just nodding to fall," &c. This author does not seem to have been struck with this odd circumstance of the twisting round of the chimneys, and offers no explanation. The next instance that I have found is in the account of the great earthquake of Calabria, in 1783, as recorded by the Royal Academy of Naples, quoted by Mr. Lyell, in his Principles of Geology, vol. i. page 482. After describing several other remarkable phenomena, tending to show the great velocity of the shock, such as that many large stones were found, as it were, shot out of their beds in the mortar of buildings, so as to leave a complete cast of themselves in the undisturbed mortar; while, in other instances, the mortar was ground to powder by the transit of the stone, he says—"Two obelisks placed at the *extremities* of a magnificent facade in the convent of St. Bruno, in a small town called Stephano del Bosco, were observed to have undergone a



movement of a singular kind. The shock, which agitated the building, is described as having been horizontal and vorticose. The pedestal of each obelisk remained in its original place; but the separate stones above were turned partially round, and removed sometimes nine inches from their position without falling." This is all that Lyell says upon the subject; he contents himself apparently with the vorticose account of the Neapolitan academy.

I have found some few other notices of similar phenomena in old books of travels. Two additional instances, however, will be sufficient. The first will be found in the quarterly journal of the Royal Institution, in a narrative of the earthquake in Chili, of November, 1822, communicated by F. Place, Esq.

The church of La Morceda, at Valparaiso, stood with its length, north and south, built of burnt bricks. (The houses are built of adobes, or sun-dried bricks.) "The church tower, sixty feet high, was levelled; the two side-walls, full of rents, were left standing, supporting part of the shattered roof, but the two end-walls were entirely demolished. On each side of the church were four massive buttresses, six feet square, of good brick-work; those on the western side were thrown down and broken to pieces, as were two on the eastern side. The other two were twisted off from the wall, in a north-easterly direction, and left standing." The direction of the shocks were thought to be either from the south-west, or from the north-west.

We shall see hereafter evidence in the twisting of the two remaining buttresses, that the former was the real direction of the shocks, and that there was no vorticose motion, (indeed, the idea of two vortices, with centres only a few feet apart, is absurd upon the face,) but that the twisting of the buttresses is accounted for simply by a straight line movement, in connection with the attachment of the buttresses at one side, to the flank wall of the church.

The last instance I shall quote is from the pages of the able and delightful Darwin, in his Journal of a Naturalist's Voyage, (Colonial library edit. p. 308,) in describing the effects of the great earthquake of March, 1835, upon the buildings in the town of Conception; and after noticing, also, the evidences of immense velocity in the shock, by which the projecting buttresses, from the nave walls of the cathedral, had been cut clean off close to the wall, by their own inertia; while the wall, which was in the line of shock, remained standing. He proceeds—"Some square ornaments on the coping of these same walls were moved by the earthquake into a diagonal position. A similar circumstance was observed after an earthquake at Valparaiso, Calabria, and other places, including some of the ancient Greek temples," (for which he quotes Arago, in L'Institut. 1839, p. 337, and Miers' Chile, vol. 1, p. 392.)

"This twisting displacement," he proceeds, "at first appears to indicate a vorticose movement *beneath each point,* thus effected; but

tions; nevertheless, whenever it was possible to use the exp

Q

this is highly improbable. May it not," he adds, "be caused by a tendency in each stone to arrange itself in some particular position, with respect to the lines of vibration, in a manner somewhat similar to pins on a sheet of paper when shaken."

The sagacity of Darwin at once showed him that the vorticose hypothesis was most improbable, and that in order to its being able at all to account for the phenomenon, a separate vortex must be admitted for every separate stone found twisted, the axis of relations of the vortex having been coincident with that of the stone: besides this paramount improbability, therefore, a little further reflection would have led either Lyell or Darwin to estimate the necessarily inconceivable velocity of motion, at the extremity of the radius of one of these vortices, even if assumed at no more than a few hundred feet, in order that its velocity, within a few inches of the centre, should be so great as to wrench out of its mortared bed, and twist a block of masonry by merely its own inertia.

Considering these circumstances, on lately reading the foregoing passages of Darwin, I was soon led to see that the twisting phenomena observed, could be readily accounted for upon the established principles of mechanics, without having recourse to either vortices or vibrations, arranging blocks of many hundred weights, after the manner of pins on paper, or sand on one of Chladni's acoustic plates—an explanation which, with all my admiration of Darwin, appears quite as far from probability as its predecessor.

I assume, then, nothing more than what is universally admitted, that during earthquakes a motion of some sort takes place, by which the ground itself, and all objects resting upon it, are shaken or moved back and forwards, by an alternate horizontal motion, within certain narrow limits, which, for all present evidence to the contrary, may be a straight line motion, though possibly variable in direction at different, and sometimes closely successive times, and the velocity of which is sufficient to throw down or disturb the position of bodies supported by the earth, through their own inertia.

Let us now apply this to the cases described of stones twisted on their bases, and the explanation will at once come to light.

If a stone, whether symmetrical or otherwise, rest upon a given base, and that motion be suddenly communicated horizontally to that base in any direction, the stone itself will be solicited to move in the same direction, and the measure of force with which the movement of the base is capable of affecting the stone or other incumbent body, is equal to the amount of friction of the latter upon its base—a function of its weight, which, without the intervention of cement, may be from one-fifth to one-tenth of the weight of the body, for cut stone resting on cut stone, but may be increased to any amount by the intervention of cement.

The stone, however, is possessed of weight, and, therefore, of

inertia; that is to say, being at rest, its whole mass cannot be instantly brought into motion by the plane, and if the amount of adhesion between the stone and its bed be less than the inertia due to any given velocity of horizontal movement of the bed, the bed will move more or less from under the stone, or the stone will appear to move in a contrary direction to that of the motion of its bed.

Now, the inertia of the stone, which is here the resting force, may be considered to act at the centre of gravity of the body.

The impelling force is the grasp of the stone, which its bed holds of it by friction or adhesion; and this may also be referred to some one point in the surfaces of contact, which we might call the centre of adherence.

If, then, a stone or other solid body rest upon a horizontal plane, which is suddenly moved with sufficient velocity to effect motion in the incumbent body, three several conditions of motions of the body may occur, according to the respective position of the centre of gravity of the stone, and of the centre of adherence.

1st. The centre of gravity of the stone may be at such a height above the base, that it shall upset by its own inertia. This is the case with houses, towers, walls, &c. &c, when they fall by earthquakes, accompanied by *dislocation of their parts.*

2nd. The centre of adherence may be in a point of the base, plumb under the centre of gravity of the stone; or in a vertical plane, passing through the centre of gravity of the stone, and in the direction of motion of the base.

In this case, the stone will appear to move in the opposite direction to that in which the base has moved; that is to say, the stone may have acquired more or less the direction of motion of the base, according as the motion of the latter has been longer or shorter continued, or less or more rapid; but, in so far as the movement in opposite direction has taken place, the base, in reality, has slipped from under the stone.

3rd. The centre of adherence may neither be plumb under the centre of gravity of the stone, nor in the plane of motion passing through its centre of gravity, but in some point of the base outside the line of its intersection by this plane; in which case, the effect of the horizontal rectilineal motion of the base will be to twist the stone round upon its bed, or to move it laterally, and twist it at the same time, thus converting the rectilineal into a curvilineal motion, in space. The relative amount of the two compounded motions being dependent upon the velocity and time of movement of the base, and upon the perpendicular distance measured horizontally at the surface of adherence, between the centre of adherence and the centre of gravity of the stone.

This latter case is that which applies to the twisted stones of Calabria, South America, and Greece; and affords, as I feel assured, the true explanation of the phenomena.

tions; nevertheless, whenever it was possible to use the

The relation of these forces, which have taken so many words to state correctly, might, of course, have been expressed algebraically in three lines; but as this would not be universally intelligible, I have preferred the more tedious and intelligent statement of words; and to render the matter quite familiar, have prepared a model of one of the Calabrian pedestals, figured by Mr. Lyell, which will exhibit to the eye all the phenomena already adverted to, by giving by the hand a rectilineal horizontal motion to the base.

I have now proved that no vorticose motion is requisite to account for the twisting of obelisks, &c. &c., as observed in earthquakes, that nothing more than a simple horizontal rectilineal motion is demanded; but, it may be asked, if this rectilineal horizontal motion in earthquakes be an alternate one also—if the earth shake both back and forwards—how is it that these and other displaced bodies are not moved back into their places again by the reverse motion, by the same sort of motion, acting in the contrary direction?

This question is, I believe, fertile in consequences, and its consideration has led me to some further conclusions as to the nature of earthquake motions. After looking through a great number of authors, on earthquakes, I have not been able to find one that has endeavoured, far less succeeded, in shaping to himself any distinct notion as to what the precise nature of the earthquake movement is. The ancients, appealing to their senses, so far as these could guide them, thought that it was like the shaking of a sieve, as the word σεισμος tells us. The moderns in general are not more exact in their notions: "a trembling," a "vibration," a "concussion," a "movement," and so forth, are the words we find scattered through even scientific authors. Mitchell, Lyell, and Darwin, with some others, although they obviously have formed no distinct idea on the subject, use the word "undulation," and in so far, have come nearer to the truth; for it appears to me, that the fact, that displaced bodies are not occasionally replaced, in earthquakes, is conclusive evidence of either one or other of two things.

Either the motion is limited to horizontal direct movement, in one or more directions; and, if so, the whole mass of the disturbed country must be pushed bodily forward, and remain so, of which there is no evidence; and all bodies must, as the effect of one shock, fall in the one direction, and not in opposite directions, which is contrary to observed facts.

On the other hand, if the movement be an alternate horizontal motion, as all observations go to prove it is, then the motion in one direction must be slower than in the other, or attended with other differences of circumstances. The backward motion must be different from the forward motion, or otherwise displaced bodies would be replaced by the recurrence, in the opposite side of forces similar and equal to those that just set them in motion; but they are not found so replaced.

One reason why the displaced body is not replaced in the great majority of cases, has been suggested to me by my friend, Dr. Apjohn, namely, that the chances are incalculably small, that the displacement should be attended with such a set of conditions, that the backward motion should precisely end in a replacement. This is true, but not a sufficient account of all the circumstances.

Now, of all conceivable alternate motions, the only one that will fulfil the requisite conditions observed, namely, that shall move with such an immense velocity, as to displace bodies by their inertia, or even shear close off great buttresses from the wall they sustained, (Darwin) or project stones out of their beds, by inertia; that shall have a horizontal alternate motion, either much quicker in one direction than in the other, or different in its effects; and that shall be accompanied by an upward and downward motion at the same time—a circumstance universally described as attendant on earthquakes—the only motion, I say, that will fulfil these conditions, is the transit of a great solitary wave of elastic compression, or of a succession of these, in parallel or in intersecting lines through the solid substance and surface of the disturbed country.

This idea of the general nature of earthquake motion, viz., that it consists of a wave of some sort is not, however, new, although so entirely neglected by the mass of recent geological authors. To the Rev. John Mitchell, M.A., Fellow of Queen's College, Cambridge, the merit of this idea is originally due. In a paper communicated to the Royal Society, read in 1760, and published in the 51st vol. of the Philosophical Transactions, part 2nd, he treats, at length, of the origin and phenomena of earthquakes, and distinctly enunciates the following view:—

That the motion of the earth is due to a wave, propagated along its surface, from a point where it has been produced by an original impulse. This impulse, he conceives, to arise from the sudden production or condensation of aqueous vapour, under the bed of the ocean, by the agency of volcanic heat, the supposed mechanism of which he minutely describes.

I trust I shall be able on a future occasion to prove, that this mechanism is sustained by an hypothesis wholly baseless, that Mr. Mitchell not only mistook the *order* of wave which he assigns to earthquake motion, but that granting his hypothesis, the conclusions, as to the nature of wave motion which he deduces, or which are directly deducible from it, are alike inconsistent with the laws of physics, and the observed phenomena of earthquakes. In a word, that nothing remains of Mitchell's theory, beyond the fact, that earthquake motion consists in the transit of a wave of some sort.

[illegible]; nevertheless, whenever it was possible to use the e

"On the Disease of the Potato, with reference to Soils," by William Andrews, Esq., M.R.I.A., &c.

Mr. Andrews gave a brief account of some inquiries he had made with reference to this subject, with a view to ascertain, if possible, what influence variety of soil had exerted on the soundness of the potatoes grown in it; but these inquiries were not as yet complete.

January 14th, 1845.—"Further remarks on the Trap Rocks of the County of Limerick," by C. W. Hamilton, Esq., M.R.I.A., F.G.S., Lon. President of the Society.

I need not recapitulate the previous authorities upon the subject of these rocks, as I did so in my last paper.

The object of that paper was to describe a few sections, from which I gathered the fact, that the Trap rocks, composing the hills of Knockrnagh, Pallas, and Grange, over Lough Gur, were apparently stratified, and lying regularly between an upper and under bed of limestone, occupying the place which the calp occupies in other parts of the same county.

I now proceed to enter into some further detail respecting the boundaries of these different rocks, and to record some observations upon the surrounding district, which, I am in hopes, may lead to a more satisfactory classification of the Trap rocks, and harmonize much that may have appeared contradictory in the statement of previous observers. I feel that I owe some apology to the society for bringing before them fragments of travelling observations. A laborious profession occupies my time too much to admit of a more minute investigation of the districts I occasionally visit: but I have always thought that even one observation, carefully made, and tending to correct an error in a published map, was worthy of being recorded in this society; and no one would rejoice more than I, if the discussion arising out of these questions led others who have more leisure to pursue the subject further, to unravel the difficulties which stood in my way, and point to the path of truth, even were it other than that in which I had trod.

What led to my revisiting the district was the incongruous jumble of different rocks, pourtrayed in the last edition of Mr. Griffith's map. In one part of the county, patches of calp, lying over the under limestone, in another, the upper and under limestone, coming together, each occasionally in juxta-position with the Trap, which was represented as obtruded patches—here bursting through the old red sandstone, there breaking through the under limestone, and again, in other places, through the upper limestone, without upturning the edges of the underlying rocks. All this appeared to me to be unsatis-

factory, and indicative of errors, or of an incongruity of arrangement, which I had not met with elsewhere; and when I found that every observation I made led me further from the conclusion Mr. Griffith had drawn, I felt as if I should have been an unworthy member of this society if I had hesitated to communicate my ideas to you.

A great extent of the country is so covered, that direct observation is impossible; and the boundaries of the strata must be laid down, by a connection of the points in which observations have been taken. I have showed upon the map, by means of dark lines, those portions of the boundaries, which I think myself justified in laying down as the result of direct observation. Upon the copies of the ordnance sheets, belonging to this society, you will find most of the actual observations marked. Those which I made are in red ink; those which were made by Mr. Oldham in black ink; and thus any one, who differs from us in the conclusions we may each draw, may take those maps and satisfy himself as to the correctness of the data from which they are drawn.

To begin with the inner belt of Trap, that bed which lies between the upper and the under limestone, from Grange hill, which I described in my former paper, I traced both boundaries to Herbertstown, the long street of which village covers the breadth of the Trap, which is seen in immediate contact, supported upon the lower limestone at its southern extremity, and supporting the upper limestone at its northern, from whence the boundary, with the upper limestone, is again traceable at Rathjordan, from which place we lose it until we find it again in the valley, east of Drumkeen; here it forms a synclinal, supported on the Trap, and the lower beds lying next to the trap contain an abundance of spirifers.

From Drumkeen to the quarries, south of Knockruagh, there can be little doubt of the direction it takes, connecting these points. The connection between the upper limestone and the millstone grit is clearly shown at Ballybrood, and easily traceable round the margin of this isolated patch of the coal measures, originally, perhaps, united with those which occupy the western extremity of the county. To return to Herbertstown, the contact of the trap and the lower limestone may be seen at the south of Wonder hill, and again at the south-west of Kilteely hill. The facade of Kilteely is an outcrop of strata, which dip to the north. It is worthy of observation, that the same beds, which in one place compose a part of that strikingly columnar precipice, may be traced, within a few paces to the west, and along the line of strike, gradually losing the columnar structure, and appearing as simply stratified. The junction is evident from Kilteely to Derk, and thence from the north of Barna, by Pallas Grean, and Nicker, to Drumkeen. At Nicker there is a difficulty which I have not succeeded in unravelling: there appears to be a third bed of limestone, as described by Mr. Weaver; but as I

tions; nevertheless, whenever it was possible to use the exper

did not trace this bed along the line of junction, I think it probable that it will turn out to be owing to a fault, or perhaps, as Mr. Oldham suggests, a slip, by either of which causes one bed might be twice seen in the ascent of the hill; the steepness of the incline reduces the scale on the ordnance map, so as to make it difficult to reason upon observations laid down upon it, and it would probably require an actual survey to establish the relations with accuracy. I am not sure whether the ridge of Derk may not continue to the east, and be found to be connected with the Trap, described by Doctor Apjohn, as lying upon the limestone at Colla. I have not traced the boundary from Drumkeen to Cahirconlish, but from the hills east of Cahirconlish to Ballynaguard it is clear and well defined. So far, then, I think, I have shown evidence of a basin, in which the lower limestone, the trap, the upper limestone, and the millstone grit form a regular ascending series. I have now to add, that I have examined an outer belt of Trap rocks, in which, although I did not find the directly exposed junctions that I did in the other instance, yet the anticlinal dip of the Trap itself, and the very near approach of the limestone dipping from it wherever observed on either side, lead naturally to the conclusion that this Trap underlies the under limestone—a fact maintained by Doctor Apjohn, in reference to the limestones of Castleguard and Mount Catherine. I believe the traps of Cahirconlish, Syon Hill, Sunville, that running along the junction of the two counties, near Cullen, and the hill to the north of Kilballyowen, to belong to the same formation, and to be probably much more continuous than the nature of the ground, which is much covered, and the shortness of the time I could spend there, would allow of my tracing out. The hill to the north of Kilballyowen has an extraordinary resemblance to the description which Darwin gives of extinct volcanoes; but I did not trace this resemblance beyond outward forms and great alterations in this rock, which is, in many parts, a true syenite. I regret not having been able to examine it more minutely, as, if evidence of an outburst is found any where, it will probably be there. The mineral character is variable, but still sufficiently distinct from the upper beds; the distinctions consist in a more conglomerate structure—a comparative absence of lime, and a prevalence of large crystals of felspar.

In my former paper I stated that I could not find any trap protrusion, where such was marked in Mr. Griffitth's map, as occurring to the north of the summit of Knockfierna. I have again visited that hill, and remain of the same opinion. What Mr. Griffith has represented as trap erupted, I believe to be the beds of the old red sandstone, altered from the condition in which they were originally deposited, and I believe that the same beds may be seen occurring on the east and west along the line of strike in their original unaltered condition. The altered beds assume all the mineral structure

of the outer series of trap rocks that I have just described; and, I think, there is every reason to believe that they owe their origin to a deposit similar to that of the Knockfierna range of hills, and have been crystallised and altered by the same agent, and at the same period as the beds to the north of Knockfierna. If this view should prove to be the correct one, we shall have to add another basin of old red sandstone supporting the series, before described.

That each of these beds of trap rocks were originally deposited from water, appears to me not to admit of a doubt. The English geologists will tell you that they were so, but explain the presence of augitic minerals and many more serious difficulties, which the metamorphic theory has to contend with, by supposing that the deposit was one of volcanic ashes and pumice, into which lime and other soluble matters were subsequently infiltrated. Far be it from me to feel any sure confidence in my own opinion, when I find that it differs from that of men whose opportunities of observation have been so much more extended than mine; but I should consider myself unworthy to open the book of nature, and attempt to read a page out of it to others, if I did not honestly interpret the sense which the letters that I read conveyed to me; and I confess that I see in the character of these rocks so decided a similarity between them and the new red sandstone conglomerate, altered by a trap dyke on the shores of the Menai, described by Mr. Trimmer in this society, (Jour. G. S. D. Vol. II. Page 35,) that my mind naturally leads me to attribute a similar effect to a similar cause.

Upon examination, with a lens, the finest grained and most basaltic-looking specimens differ from the coarser Trappean conglomerates, only in the size of the component grains; in some the quartz remains granular, while the interstices contain beads and polished threads of black and white, and all the appearance that is produced by the partial fusion and production of black and white enamels, when a thin splinter of some of the aluminous sandstones is held for a short time in the flame of a blowpipe. Pumice and lava are easily distinguishable; they have generally the appearance of a viscous substance, through which air has been struggling to free itself. There is one specimen in your cabinet labelled as volcanic, which approaches very closely to the character of the upper beds, which I have been describing; so that here mineral character is not a guide to be depended upon.

One remarkable feature in this district is the absence of those numerous dykes which traverse the rocks of the same age in other parts of Ireland. I have, however, observed one instance in a quarry adjoining the road, near the gate of Ballynaguard. The position of the limestone here is rather ambiguous; but in the quarry I allude to, a mass of trap forming a steep inclination, running east to west, supports thick beds of limestone, the edges of which are bent up, as in the section where it comes in contact with the

tions; nevertheless, whenever it was possible to use the ex

trap: there are also lumps of limestone imbedded in the trap, and at the eastern end of the quarry there is a dyke-like wall of another substance, standing upright, and about seven or eight feet wide, sending off, as it were, a stream over the edges of the limestone; it is soft, soapy to the touch, and fuses very easily into a dark enamel before the blowpipe. I believe the disturbance to be connected with the old red sandstone, and coeval with its alterations.

There is one curious instance of violence observable in the lower beds of the limestone at Carrickkittle rock, east of Kilteely. Here the lower limestone is tilted up on its edges, but at the base there is part of one bed apparently reduced to the condition of boulder gravel, and I am inclined to attribute this appearance to violent and irregular action from beneath. I think that from what I have stated, it may be gathered that these five members of the carboniferous series were deposited in succession, and not disturbed until some period subsequent to the deposit of the millstone grit, and that then came a period of very great disturbance, during which the Keeper, Gaulty mountains, Cahirconree, and the Reeks were elevated, and the basins inclined between them, compressed and broken, and some of the rocks subjected to such alterations. The extent and magnitude of the change which took place seems to argue a deep-seated and very powerful action, and this may, perhaps, explain both the variety of Plutonic streams breaking through the surface, and the extent to which the influence of subterranean heat appears to have reached. In reasoning upon the causes of fusion and alterations, we must not connect with the idea of heat merely that burning power which we see in the flame of the most powerful blowpipe or furnace, but remark that the most stubborn substance yields to the electric current as easily as to it. We must not conclude hastily which of two known causes have produced the same effect. There can be no doubt that a volcanic eruption must give rise to stratified sedimentary rocks, composed of volcanic matters; but, on the other hand, there is as little doubt that the deposit of a sea, such as the new red sandstone on the shores of Menai, is altered by the contact of a trap dyke, or lava current, so as to wear exactly the appearance of some of the rocks I have described. Where I find evidence of limestone and traps deposited conformably, I look to position as guiding me in the comparison, and, I think, that if so great a thickness of volcanic breccia had been deposited at the same time that the calp was, the deposit must have been accompanied by a disturbance of the subjacent rocks, which would have led to unconformability in the breccia. Every observation I have made tends towards the idea that the fusion of a rock and the eruption of a volcano is only the last term in a series of alterations, and that we are yet far from being able to say that this or that substance is the original frame-work of the earth, from the decomposition of which the sedimentary rocks were derived.

"Of the order of succession of the strata of the south of Ireland, with a particular reference to the Killarney district of the county of Kerry." By Richard Griffith, V.P.G.S.D., &c.

The object of my present communication is to explain my views relative to the order of succession of the several series of rocks which occur in the south of Ireland, with a view to determine the true geological position of each. Having once determined the order of succession, we next investigate the fossil organic remains that may have been discovered in any series, and by this means determine their names, according to the Palæozoic arrangement, which at present prevails; but in those suites of strata, in which no fossils occur, of course, we must reason from analogy and lithological character.

I have been induced to come forward on the present occasion in consequence of a paper communicated to the society at its last meeting, by Mr. C. W. Hamilton, the President of our society, in which he endeavours to show that a portion of the strata of the south of Ireland, and particularly of the counties of Kerry and Cork, which I have coloured on my geological map, as upper Silurian, should be classed with the Devonian series. Now, this is precisely the place where a difference of opinion is likely to occur, because no fossils have hitherto been discovered in the series to assist us in determining the name by which it should be called. The geological position has been ascertained: the series in question is certainly interposed between the upper Silurian of Ferriter's Cove and the old red conglomerate, which usually forms the base of the old red sandstone, or Devonian series, both of the Cahirconree and Slieve-mish mountain range, of the Dingle peninsula in Kerry, and of the Galties and Slieve-na-man and Monavoullagh mountains of the counties of Limerick, Tipperary, and Waterford; and, I am of opinion, that the red conglomerate which rests conformably on the quartzite and purple slate series of Macgillacuddy's reeks, is identical with the conglomerates of the localities just mentioned.

I shall shortly state my reasons for considering the conglomerate of Waterford, Tipperary, and Kerry to be the base of the old red series. If we look to the geological map of Ireland, and trace the line of bearing of the Cahirconree range of Kerry, we find that a ridge extends eastward in the same line, nearly as far as the valley of the river Barrow, at New Ross, in the county of Wexford; in this ridge the principal features are the Galties and Slieve-na-man mountains.

Now, all these mountain ranges are composed of a base of schistose strata, capped unconformably by red conglomerates, sandstones, flags, and slates belonging to the old red sandstone, or Devonian series.

If we examine that of the Cahirconree and Slieve-mish mountains of Kerry, we find that the schistose base (the particular cha-

tions; nevertheless, whenever it was possible to use the expe

racters of which I shall describe presently) is succeeded on the summit of the ridge by strata, occupying nearly a horizontal position, but dipping to the eastward, and which rests on the ends of the schistose strata, which effect nearly a vertical position.

In this locality the under beds of the old red series consist of rather fine-grained red quartzose sandstone, for a thickness in different parts of the district, varying from 100 to 150 feet, succeeded by thick beds of coarse conglomerate, alternating with coarse red slate, and these, in continuation by alternations of red and brown quartzose sandstone and red slate, amounting altogether to a very considerable thickness, say 2000 feet.

The strata of old red sandstone of the Galties and Slieve-na-man mountains are similar in position and composition with those just mentioned, and rest unconformably on schistose strata, which I refer to the *lower Silurian* series. If leaving this remarkable line of elevations, we proceed to the southward, and examine the coast of the county Waterford, at Ballyvoil Head, we find a similar arrangement of strata; here, also, the base consists of schistose strata, belonging to the lower Silurian period, which are covered in an unconformable position.

1st. By strata, consisting of alternations of reddish grey and red conglomerates, reddish grey compact sandstone, and dark red slate, the conglomerate predominating; the thickness of these alternating strata is about 300 feet.

2nd. Dark reddish grey clayslate, reddish grey quartzite, and sandstone, the slate predominating; thickness about 300 feet.

3rd. Dark red micacious sandstone and red clayslate, with occasional beds of conglomerate, the sandstone predominating; thickness abont 750 feet.

4th. Dark red slate, red quartzite and sandstone, the slate predominating; thickness about 300 feet.

5th. Brownish red quartzose rock, red clayslate, and yellowish grey sandstone, the sandstone predominating: dip 20° west of south, on an average at an angle of 65°: thickness about 600 feet; making a total of about 2250 feet. These are succeeded conformably by strata, referrible to the carboniferous period.

If we follow the outgoing of the conglomerate from Ballyvoil Head to the northward, we find it extending uninterruptedly for upwards of twenty miles along the eastern declivity of the Monavoullagh mountains.

I bring forward these several sections of the old red sandstone from its base upwards, to show that the same succession is preserved in the series throughout the south of Ireland, and as in all the localities I have alluded to, the old red series rests unconformably on the inferior rocks, which, as I shall presently prove, do not all belong to the same geological period, we may reasonably arrive at the conclusion, that the red and reddish grey conglomerates and

sandstones which occur at Cahirconree mountain, the Gaulties, the Slieve-na-man mountains, Ballyvoil Head, and along the northern escarpment of the Monavoullagh mountains, form the true base of the old red series in the south of Ireland.

I shall next beg to direct your attention to the succession of the strata, which occur in the Dingle and Killarney district of the county of Kerry.

The lowest suite of rocks in this district consists of strata belonging to the upper Silurian series, which occur in a small district situated near the western extremity of the peninsula of Dingle, and extending for three miles along the sea coast, from Ferriter's Cove, south of Sybil Head, to Doonquin, and thence inland in a north-eastern direction to Smerwick Harbour.

These strata occupy a small elliptical-shaped district, having an anticlinal axis nearly in the centre; but, as usual, in almost all the convoluted strata of the south of Ireland the beds, both on the north and south sides, incline to the southward, the angle of inclination on the north-side being steepest; for, in fact, here, as in other southern localities, there has been an overthrow to the north.

The Silurian series of Ferriter's Cove consists of grey calcareous slate, sometimes passing into impure limestone, alternating with grey quartzite, and occasionally with red and purple slate, and red quartzite, the calcareous beds abounding in fossils belonging to the upper Silurian series.

(1.) Taking these strata as the base of the district, which they undoubtedly are, we find that they are succeeded by alternations of brown quartzite and brown slaty conglomerate, with occasional alternations of red slate.

(2.) Above these strata we have alternations of green quartzite and green slate alternating with brown quartzite and purple slate, and still ascending in the series the green quartzite is found to predominate, and the purple slate to diminish in volume.

(3.) Continuing to ascend, we find that the green quartzite gradually gives way to brown quartzite, containing pebbles of white quartz; but we still have occasional beds of green quartzite, green slate, and purple slate. These latter strata form the upper beds of the schistose series in the Dingle district; but the strata of old red sandstone, which occupy the greater portion of both the north and south coasts of the Dingle peninsula, rest unconformably on different members of this series.

The old red sandstone of the Dingle peninsula, as well as of the Galties, Slieve-na-man, and Monavoullagh mountains is succeeded conformably by strata belonging to the carboniferous period; but we shall confine ourselves at present to the strata of Kerry.

In regard to the Dingle peninsula, the old red sandstone is succeeded both on the north, east, and south sides by the yellow sandstone, carboniferous slate, and lower limestone of the carboniferous

tions; nevertheless, whenever it was possible to use the ex

Q

limestone series; and, if we traverse the limestone of the valley of Castlemaine, in a southern direction, from the old red of the north-side, we find similar strata underlying the limestone series on the south-side, in a conformable position, from the neighbourhood of Killorglin, on Castlemaine bay, to the lower lake of Killarney, the junction running through Brown's Island, in the centre of the lake, and thence to the peninsula of Muckruss, situated between the lower and Turk lakes.

The old red sandstone which underlies the strata belonging to the carboniferous limestone period, to the south of Castlemaine bay, is identical in position, as well as in lithological character, with that of the Dingle peninsula; it consists, in the upper part, of red quartzose sandstones, alternating with coarse red slates, some of which, as in the Gap of Dunloe, are occasionally used as roofing slates for inferior buildings; and descending in the series we arrive at a red conglomerate, identical with those of Cahirconree, Ballyvoil Head, &c.; and beneath the conglomerate we find a dark red quartzose sandstone, identical with that of Cahirconree, already mentioned, which rests unconformably on the schistose strata belonging to the upper Silurian period, and which, for the reasons already given, I consider to be the bottom of the old red series of the south of Ireland.

We now come to the vexed point, namely, the strata which lie beneath this undoubted old red. They consist, first, of reddish grey quartzite, alternating with red slate; on a fresh fracture the colour of the quartzite is darker than on the weathered surface. Descending in the series, we pass into a gray quartzite, alternating with purple slate, beneath which we have brown quartzites, frequently containing pebbles of white quartz, alternating with purple slate, and still descending, we have green quartzites occasionally alternating with brown quartzites; and still lower, as in the Gap of Dunloe, the valley of the Upper Lake, Cromagloun, Turk mountain, &c., we have green quartzites, alternating with green, and occasionally purple slates, which latter, form the lower part of the graduating series in the Killarney district, and which, together with the strata which immediately rest above it, are identical in composition and lithological character with the green quartzites, purple slates, and brown conglomerates, which rest conformably on the Silurian rocks of the Dingle peninsula.

To elucidate the subject, in addition to a section made by me for a paper published in the *Philosophical Magazine* for March, 1840, and to which I shall have occasion presently more particularly to allude, I have constructed a new one on much more accurate data, having the ordnance survey as the ground-work both for the distances and the elevations, the succession of the strata being laid down from observations made with great care. This section (pl. 1, fig. 1,) is constructed on a scale of six inches to a statute mile,

both for horizontal distance and heights, and extends in a straight line from Killorglin, in the limestone valley of the river Laune, on the north, in a nearly southern direction, across the strike of the strata, over the summit of Coomeenpeast mountain, and thence crossing the valley of Coomyduff, continues to the limestone valley of Kenmare, being nearly parallel to my former section, but constructed on a different scale of length and heights.

Mr. Hamilton asserts that there is an anticlinal axis passing through the Reeks, and a synclinal axis in the valley of the Brown River, Coomyduff, and the upper lake of Killarney. Mr. Hamilton's sections, as published in his paper in the *Philosophical Magazine*, vol. xv. page 142, represent the summit of the Reeks, immediately to the west of the Gap of Dunloe, as composed of old red sandstone, or Devonian strata, inclining to the north, and resting unconformably on Cambrian rocks, which, in the same paper, he describes as occurring in the Gap of Dunloe. In his recent paper he does not allude to this fact, and I shall pass it over, for the present, as I mean again to recur to it.

In his recent paper Mr. Hamilton makes the old red conglomerate of the Reeks to form the base of the whole of the strata, which lie to the south of it, at least as far as Coomyduff, and this is effected by an anticlinal axis in the summit of the Reeks; but I maintain that Mr. Hamilton is as incorrect in his new views as he was in the older ones, as published in the *Philosophical Magazine*.

It is quite true that the conglomerate and red strata on the summit of the Reeks, in common with the other parts of the country, are convoluted, or waved, in the direction of the strike, into numerous minute anticlinal and synclinal axes; but although the conglomerate beds on the summit of Coomeenpeast, Carrantuohill, and the other mountains of the range, present an undulatory arrangement, still there is no general anticlinal axes. On approaching the summit of Carrantuohill, from the north, we find that the series of the quartzite and schistose strata, already described, are succeeded in a conformable position by cherry-red quartzose sandstone, dipping 15° east of south, at an angle of 40° from the horizon. These strata are followed in an ascending order by red sandstone, conglomerates, and coarse red slates, which are identical with those which are interposed between the limestone of the valley of the Laune and the quartzite strata. These sandstones continue to the top of the mountain, where they are observed to form a saddle-shaped convolution, dipping in opposite directions, the dip to the northward being steep, and that to the southward comparatively gentle. In crossing over the summit, and proceeding to the southward, towards Coomyduff valley, the dip is observed to change from south to north, and continuing to descend to the south, we soon reach the quartzites and purple slates, still dipping to the north, and underlying the conglomerate beds, which are represented on my original and recent

tions; nevertheless, whenever it was possible to use the exp

Q

sections, as confined to a cap, which forms the summit of the Reeks.

The section near the summit of Coomeenpeast is very similar to that of Carrantuohill, though not identical with it; for where the strata are arranged in numerous small convolutions or waves, it is impossible, in a great mountain ridge, to find your place exactly on different summits.

Here, then, is Mr. Hamilton's anticlinal axis, which extends through the Reeks, and in continuation by the Purple and Glena mountains to the Lake of Killarney. I assert, in the most decided manner, that no such axis does exist; on the contrary, when taken on the large scale, the mountains rather assume the appearance of an elevated trough. But in addition to my section through the ridge of the Reeks, the section of the strata presented by the precipitous escarpments on the east and west sides of the Gap of Dunloe, which cuts through the Reeks, across the strike of the strata, will prove the accuracy of my views. Taking the west side of the Gap of Dunloe, from the fault at Coosane Lough, and proceeding in a southern direction, we find that the strata consist of a series of small undulations for the entire distance, between Coosane and the opening of the valley of the upper Lake of Killarney. This does not look like one great anticlinal; but as an additional proof, I have to add, that the green quartzites and green and purple slates of the Gap of Dunloe extend uninterruptedly for the entire distance, from the fault at Coosane into the valley of Coomyduff. Now, Mr. Hamilton, in his section, makes the conglomerate of the Reeks extend down the southern declivity of the mountain into the valley of Coomyduff; but, unfortunately for the accuracy of his views and observations, the strata at Coomyduff are not red conglomerate, but the green quartzite of the base of the series, which, as I have just mentioned, are continuous from the Gap of Dunloe; and, in fact, he has mistaken the bottom for the top, and connected them accordingly.

Mr. Hamilton makes the valley of Coomyduff a synclinal axis. I assert it is no such thing; on the contrary, its green quartzite strata present a flat anticlinal axis, and I rather consider it to be a valley of elevation.

I have now done with Mr. Hamilton's views on this part of the subject, and I will return, for a few moments, to the consideration of the general subject, as it regards the name which should be given to the series in dispute. As I have already said, the position of the strata, in geological sequence, has been ascertained, and no fossils have as yet been discovered. There can be no doubt the series is interposed between the upper Silurian and undoubted beds of the old red sandstone; to which, then, does it belong? On referring this question to my friends, Mr. Murchison and Professor Phillips, who made a rapid tour through a part of the country after the meeting of the British Association for the advancement of science, at

Cork, they gave it me as their opinion, that the entire series, from the upper beds of the fossiliferous Silurian rocks of Doonquin, in the Dingle district, should be called old red sandstone; but as Professor Phillips said, "*very, very old red, grown grey with age.*" This is high authority, to which I should be much inclined to submit; but had my friends examined the entire district, or had they examined the base of the old red sandstone, as it rests unconformably on the Silurian slate of the several mountain ranges of the south of Ireland, which I have already enumerated, they might have arrived at a different conclusion; but, in addition to the facts already adduced, I have a strong case of analogy afforded by the section of the upper Silurian series of the county of Galway, and which extends northward from Blackwater Bridge, on the northern edge of the mica slate district of Connemara, and thence to Killery Harbour. Commencing from the base which rests unconformably on the mica slate, we have first a reddish brown quartzose sandstone, succeeded by grey quartzose rocks, which are frequently conglomerate. These strata may be about 500 feet in thickness, though in some localities they may amount to 1000 feet. They are followed by a series of grey quartzose and schistose beds, some of which are calcareous, and abound in fossils of the upper Silurian series, the names of which are contained in my paper, printed in the Transactions of the Geological section of the British Association at the York meeting.

The fossiliferous beds may be about 700 feet in thickness; above them we have alternations of red slates, green quartzose, and green slates, amounting in the whole to a thickness of at least 2000 feet, which are identical in structure and composition with those of the Dingle peninsula and the district of the Reeks. On top of these latter strata are two thin bands of limestone, which are soon succeeded by the remarkable conglomerate, which contains large pebbles of granite, which forms the uppermost rock of the district.

In this section fortunately the limestone beds are fossiliferous, though sparingly so, and contain atrypæ, leptœnæ, and corals, similar to those found near the bottom of the series; and hence, the whole, as far as the conglomerate at least, must be included in the Silurian system.

Here, then, we have a strong analogy of a series of rocks, in every respect similar to those of the Kerry districts, and exceeding 2000 feet in thickness, which lie above the principal fossiliferous beds, and which must be included in the Silurian series. Under such circumstances, should we not pause before we decide on the Palæozoic appellation which should be given to the green and grey quartzites of the Kerry districts?

I have thought it desirable to state my opinions relative to the succession of the strata throughout the south of Ireland, previously to entering on the particular points, treated of by Mr. Hamilton in

tions; nevertheless, whenever it was possible to use the exper

Q

his paper communicated to the society at its last meeting. In this paper Mr. Hamilton differs from me on general grounds, namely, that he considers the whole, or the greater part of the mountain district of the county Kerry to be Devonian, while I arrange it as upper Silurian, graduating into old red sandstone, or Devonian. Had Mr. Hamilton confined his views to this point, I should have said no more at present; but, he not only differs from me on the great scale, as to the proper name to be applied to the series, but also in regard to the internal structure of the country. Mr. Hamilton, near the commencement of his paper, states, that in my geological map of Ireland, published in 1838, I assigned to the Cambrian period the mountain district, below the conglomerate, on the summit of Macgillicuddy's Reeks and Kenmare. Now, previously to the publication of some of the papers which preceded Mr. Murchison's most valuable work on the Silurian system, I considered it, together with the slate series of Down, Waterford, Wexford, &c., to belong to the transition or Graywacke series, a name universally adopted for the newer slate series by all geologists before that time, and Mr. Hamilton himself is, I believe, the only person who ever classed any portion of the series so low down as Cambrian.

In his recent paper Mr. Hamilton has not alluded to this view, which he published in the *Philosophical Magazine*, vol. xv. page 142 and following. Mr. Hamilton's sections, which accompanied this paper, erroneously ascribe the green quartzites and purple slates of the Gap of Dunloe to the Cambrian period, and represent the conglomerate of the Reeks and of the Gap of Dunloe, as resting unconformably on the ends of the strata of green quartzite. Now, this is not the fact; and no such appearance is visible on the spot, and it would appear that the idea is now abandoned by Mr. Hamilton himself; as, in his recent paper he never alludes to his Cambrian series at the Gap of Dunloe. I made a reply to Mr. Hamilton's paper, which is published also in the *Philosophical Magazine*, vol. xvi. page 161, which can be referred to by those who wish to follow up the subject; and I merely allude to it, on the present occasion, because Mr. Hamilton, in his recent paper, quotes from it relative to the great fault which I have traced between the Gap of Dunloe and Turk Lake, at Killarney; but it is remarkable, in making the quotation, that Mr. Hamilton should have commenced his extract in the middle of a sentence. The whole sentence runs thus:—" I have also prepared two sections passing nearly through the same line of country as those given by Mr. Hamilton, from which, it appears, that the old red sandstone, on the summit of Magillicuddy's Reeks, rests conformably on the schistose rocks of the Gap of Dunloe, which Mr. Hamilton terms Cambrian, and that the apparent unconformability which is visible nearly in the centre of the Gap, between the chloritic quartz rock and the old red sandstone, has been occa-

sioned by a great north-west and south-east fault, which crosses the Gap of Dunloe nearly at right angles, and extends from thence in a south-eastern direction, along the northern declivities of the Purple, Toomies, and Glena mountains, from whence, in continuation, it reaches the lower lake of Killarney, near the Glena Cottage Banquetting-house; thence it crosses Brickeen Island, and passing through Turk Lake, reaches the north base of Turk Mountain."

Mr. Hamilton commences his quotation, omitting the beginning of the sentence, with the words, "that the apparent conformbility," &c.; this is remarkable, but I shall make no comment on it.

I shall not follow Mr. Hamilton in his arguments relative to the existence of this fault, as he could not see it. In the Gap of Dunloe it is very striking, both on the west and east sides; and when I pointed it out to Professor Sedgwick, he observed that he never saw a finer example of a great fault, and wished me to make a careful drawing of it, which want of leisure has hitherto prevented me from executing.

I am not surprised Mr. Hamilton could not see the fault, where it crosses Brickeen Island, at its southern extremity, because very much observation is required to detect it; but those who can or will examine with care may observe that on the line of the fault, laid down by me, on the map of Turk Lake, appended to my paper, (alreadv mentioned) published in the *Philosophical Magazine*, will find that the green quartzite, which extends in the strike of the strata uninterruptedly from the head of the Gap of Dunloe, in an eastern direction, to the point in question, has, in juxta-position with it, red sandstone containing thin beds of red limestone, covered by beds of yellow sandstone, containing the characteristic fucoides of the yellow sandstone series, the dip of these rocks being to the southward, and, if there be no fault, must underlie the green slate situated immediately to the south. This is a startling fact, which does not depend altogether on my own testimony; for, I pointed out the fossils on the spot to Professor Sedgwick. Now, I have shown that the green quartzites and slates of the Gap of Dunloe, the strata which Mr. Hamilton calls Cambrian, form the bottom of the great series of the Reeks. I have also shown that the yellow sandstone rests on the top of the old red sandstone series; and when we find these rocks in juxta-position, the upper rocks inclining towards the lower, and both dipping towards the south, though not exactly to the same point, we must arrive at the conclusion, either that there is a great fault, or that the yellow sandstone lies below the green quartzite, which latter, we know, cannot be the case. But let us analyze the facts contained in the map of Turk Lake, which I now exhibit on the original scale, according to which it was laid down from *actual survey*.

This map represents the fault as passing diagonally through Turk Lake, from Dinis Island, on the west, to Turk Cottage, on the east,

tions; nevertheless, whenever it was possible to use the exper

Q

and the dips and strike of the strata on both sides have been laid down with care. Mr. Hamilton observes, in respect to these dips and strikes—"Where a country is fluted in one direction, and at the same time subject to elevations or depressions along the line of strike, a careless observer, who took the horizontal line on each exposed surface, as indicating the strike, and marked down the dip as being at right angles to that line, would be liable to constant perplexity and error, and such reasoning as Mr. Griffith's might be so applied as to lead to very erroneous results."

This is rather a serious charge to make against a civil engineer, a practical miner and geologist of upwards of thirty years' standing; but neither Mr. H.'s observations nor his reasoning on them will bear the test of examination. This sentence would indicate that the flutings are in one direction and the elevations or depressions in the line of strike in another, which is not the fact; the flutings are minor elevations or waves in the line of strike, and the other greater undulations affect the same direction, and are in the strike also. How, then, can even a careless observer make a mistake as to the strike, if he takes the level of the strata on the side of one of the greater or smaller undulations? It is evident, therefore, that Mr. Hamilton has made his own observations in so imperfect a manner as not even to notice the leading fact, that the direction of all the undulations are in the line of strike.

Having examined the country, and taken the dips with great care, I assert, with confidence, that they are correctly laid down on the map, and that the facts exhibited on it prove that a fault does exist in the line indicated. On the north side of the fault at Dinis Island we have old red sandstone, succeeded by yellow sandstone, which is covered in succession by dark grey fossiliferous slate and limestone, both containing numerous fossils belonging to the carboniferous limestone series, the whole of which, as indicated by the arrows, dip towards the south, and by prolonging the line of strike across the lake, abut against the green quartzite series of Turk Mountain, which latter, as already mentioned, dips also towards the southward, though not precisely to the same point of the compass. This inclination of the limestone, &c., to the south, led Mr. Weaver to consider that the limestone of Killarney did underlie the green quartzites, &c., and hence to class it with the transition rocks. At that period fossils were not looked to as a criterion by which to judge of the geological position of rocks, and hence Mr. Weaver, not knowing of the fault, was led into error. If there be no fault, how does it happen that the great mass of limestone on the east side of Turk Lake does not appear on the west?—and how does it happen that the limestone series, instead of resting on old red sandstone, as at Brickeen, should dip towards and abut against the green quartzite at Turk Cottage?

I believe I need say no more on this point. I feel that my paper

has already far exceeded the limits I had intended; but I wish to say a few words relative to sections. Mr. Hamilton objects to the accuracy of my sections, published in the *Philosophical Magazine*, as contrasted with his own, and particularly that from the Reeks at Croomeenpeast to Brickeen Island. He says—"Mr. Griffith's second section is certainly a curious one; for three-fourths of its length it is made in the exact line of strike of the rock, in the line which I maintain to be that of an anticlinal; and then, at Brickeen, where the fault is supposed to be, the section continues at right angles to its former course, or across the line of strike."

In reply, I have to assert, that Mr. Hamilton is wrong in both his statements. First, I have already proved that there is no anticlinal axis in the Reeks; and, secondly, the section is made in a straight line from the Reeks to Brickeen; but, as it passes through two series of rocks whose strike is different, we are not to wonder that the section should pass nearly in the direction of the strike of one, and in the dip of the other.

"On the formation of Lakes on the flanks of the Commeragh and other mountains, in the County of Waterford," by Hugh N. Nevins, Esq., Waterford.

The author attributes the formation of these lakes, "which lie in amphitheatres of perpendicular rock, with an open gorge sloping gradually down to the level country," to the "slipping down of large quantities of debris from their sides in such situations as to occasion a hollow, bounded on one side by an amphitheatre of rock, and on the other by the displaced mass."

tions; nevertheless, whenever it was possible to use the experi-

JOURNAL

OF THE

GEOLOGICAL SOCIETY OF DUBLIN.

VOL. III. PART III. 1846. NO. I.

AT THE

ANNUAL GENERAL MEETING,

HELD ON WEDNESDAY, FEBRUARY 11TH, 1846,

C. W. HAMILTON, ESQ., PRESIDENT, IN THE CHAIR.

The following Report from the Council was read:—

"At the close of another year, your Council have the pleasing duty of congratulating you on the continued success of your Society. During the past year, the following have been added to your list of Members:—

HENRY AHER, ESQ. C.E.
PROFESSOR G. J. ALLMAN, M.B.
R. M. ALLOWAY, ESQ.
SIR H. T. DE LA BECHE,
PATRICK FENLON, ESQ.
WILLIAM FRAZER, ESQ. C.E.
C. B. LANE, ESQ. C.E.
JOHN NEVILLE, ESQ. C.E.

"The past year has not been marked by any special additions to your collection, but the Council would at the same time direct your attention to the valuable specimen of Euomphalus cristatus, *(Phillips)* presented by Archdeacon Verschoyle; and they have the gratification of knowing that an interest in the science is spreading through the country, evidenced by the frequent demands on your officers for assistance in comparing fossils, and obtaining other information.

"Your Council has again to acknowledge the continued donation of the Ordnance Survey Maps of Ireland in duplicate; and they are able to state, that they have in several cases enabled your

P

tions; nevertheless, whenever it was possible to use the experi

Q

Members to record the result of their observations with accuracy and facility.

"The abstract of the Treasurer's Accounts is annexed, by which it appears that there is a balance due to him by the Society of £7. 0s. 7½d. There are, however, arrears due to the Society sufficient to meet this demand.

"Within the last few days your Society has been presented by Her Majesty's Government, through the kind intervention of Sir Henry De La Beche, with a complete copy of the Maps and Sections published by the Geological Survey of Great Britain. Your Council cannot too warmly express their sense of the value of this donation, and look forward with great anxiety for the continuation and extension of similarly accurate work to this country."

Abstract of the Accounts of the Geological Society of Dublin, for the year ending February, 1846.

Dr.						
1845.				£.	s.	d.
To Balance of last year's account in the Treasurer's hands				1	2	10½
— Admission Fees:						
of one Member for Life	£5	0	0			
of 11 Annual Members	11	0	0			
				16	0	0
— Subscriptions of 87 Members				87	0	0
— Amount received from Institution of Civil Engineers towards the expense of Fuel, Lighting, &c.				6	10	0
— Do. for sale of Journals				0	5	8
— Balance due to the Treasurer				7	0	7½
				£117	19	2

Cr.						
1845.				£.	s.	d.
By Disbursements as follows:—						
By Assistant Secretary's Salary to 1st April, 1845,				16	13	4
— Do. do. from 1st April to 31st December, 1845,				45	0	0
— Painting, &c. (Foulkes)	£1	10	6			
— Hodges & Smith: Books	6	1	6			
— Mallet: Iron Work	1	9	6			
— Hand & Co: Coals	0	19	0			
				10	0	6
— Incidentals, Carriage, Postage, &c., as per acct.				13	18	5
— Printing Journals, Stationary, &c.				24	18	11
— Porter				3	10	0
— Collection, per centage				3	18	0
				£117	19	2

10th February, 1846. Wm. Edington, Treasurer.

We have examined the foregoing account, and find it correct. Balance due to Treasurer, £7. 0s. 7½d.

ROBERT CALLWELL, } Auditors.
WILLIAM MURRAY, }

tions; nevertheless, whenever it was possible to use the experi

List of Donations received since the last Anniversary.

TO THE MUSEUM.

1845.

Feb. 8.—A Series of Mineral and Rock Specimens, from the Pyrenees, named and catalogued, from Owen Blaney Cole, Esq. through the President.

Three Rock Specimens from the neighbourhood of Gorey, from Sir Thomas Esmonde, Bart., through Mr. Hutton.

—— 14.—Specimen of Shell Marl, from the inner lake, Lough Ree, Co. Westmeath, from Ross Mahon, Esq., Ballymahon.

Mar. 1.—Specimen of silicified wood, from Pondicherry, from Wm. Fraser, Esq., C.E.

—— 12.—One large Paramoudra, from the chalk at Moira, from Thomas Oldham, Esq.

—— 18.—Five Specimens of Fossil Plants, from oolitic formation, Yorkshire, from John Phillips, Esq.

Apr. 7.—Series of Fossils, from the Carboniferous Limestone, of the vicinity of Ballymahon, and Specimens of Hydraulic Limestone, from Ross Mahon, Esq.

—— 9.—One large Specimen of Granite, from Luggela, with Tourmaline, &c. from D. C. La Touche, Esq. through the President.

May 11.—Some Fossil Plants, from the Tipperary coal fields, from Mr. Fenlon.

A large and very fine Specimen of the Euomphalus cristatus of Phillips, from near Collooney, from Ven. Archdeacon Verschoyle.

June 8.—One large Bellerophon Apertus, from Carb. Limestone of Fermanagh, from Miss Richardson, Kesh Glebe.

—— 11.—Two specimens of Buccinum undatum, from the Eskar deposits, near Moate, Co. Westmeath, from R. Mallet, Esq.

Nov. 5.—Specimen of Granite, from Rockabill Island, from Wm. Murray, Esq.

Some Fossils from Benbulben, Co. Sligo, from Wm. Andrews, Esq.

—— 14.—Euomphalus cristatus, the cast of Specimen formerly sent, from Ven. Archdeacon Verschoyle.

Nov. 20.—Series of Fossils, from the Greensand of Blackdown and Haldown, and of the traps and porphyry rocks of Devonshire, given in exchange for Irish specimens, from Frederick Huxham, Esq. Exeter.

Dec. 18.—Specimens of Beryl, Andalusite and Granite, from Luggela, Co. Wicklow, from D. C. La Touche, Esq.

TO THE LIBRARY.

The Report of Her Majesty's Commissioners of Inquiry into the state of the Law and Practice, with respect to the occupation of land in Ireland, with parts, 1, 2, 3, 4, 5, and Index, &c. complete, from the Commissioners.

The Fauna and Flora of the County of Cork, published under the sanction of Cuvierian Society of Cork, from the Society.

Le Puits Artesien de Grenelle, from Wm. Andrews, Esq.

The Transactions of the British Association for the advancement of Science, for 1844, from the Association.

Two complete copies of the Ordnance Survey Maps of the Co. Limerick, from his Excellency the Lord Lieutenant, through Colonel Colby.

Two complete copies of the Ordnance Survey Maps of the County of Cork, from ditto.

Three Lithographic Plates of Egyptian Fossils, from Professor A. B. Orlebar, Bombay.

The Astro Magnetic Almanack for 1844, from the Author.

Annuaire du Journal des Mines, de Russia, 5 vols., 1835 to 1839, from Major General of Mines, Russia.

The Second Report of the Railway Commissioners for Ireland, with Atlas, Plans, and Sections complete, from Haliday Bruce, Esq.

Seventh Annual Report of the Dublin Natural History Society, from the Society.

Transactions of the Royal Scottish Society of Arts, Vol. III., Part I, from the Society.

The Mining Journal for 1845, from the Editor.

Resolved.—That the Reports now read be confirmed, and such parts of them, together with the Treasurer's accounts, as the Council may think fit, be printed, and circulated among the Members.

The Balloting Glasses having been duly closed, and the Lists examined by the Scrutineers, the following Gentlemen were declared duly elected the Officers of the Society for the ensuing year:—

tions; nevertheless, whenever it was possible to use the expe

President.

ROBERT MALLET, ESQ.

Vice-Presidents.

RICHARD GRIFFITH, ESQ.
JAMES APJOHN, ESQ. M.D.
JOHN SCOULER, ESQ.
C. W. HAMILTON, ESQ.
SIR H. DE LA BECHE.

Treasurers.

WILLIAM EDINGTON, ESQ.
WILLIAM MURRAY, ESQ.

Secretaries.

ROBERT BALL, ESQ.
PROFESSOR OLDHAM.

Council.

M. M. O'GRADY, ESQ. M.D.
JOHN MACDONNELL, ESQ. M.D.
FRANCIS WHITLA, ESQ.
THOMAS HUTTON, ESQ.
REV. H. LLOYD, D.D.
GEORGE WILKINSON, ESQ.
ROBERT CALLWELL, ESQ.
WILLIAM ANDREWS, ESQ.
CAPTAIN JAMES, R.E.
WILLIAM T. MULVANY, ESQ.
ROBERT KANE, ESQ. M.D.
SIR P. CRAMPTON, BART.
PROFESSOR ALLMAN.
G. A. GRIERSON, ESQ.
GEORGE V. DU NOYER, ESQ.

The President then read the ANNUAL ADDRESS. After the address had been concluded, the following Resolutions were unanimously passed:—

"That the cordial thanks of the Society be presented to the outgoing President, for his constant exertion in the cause of the Society during the past year."

"That the warmest thanks of the Society be presented to the several Officers of the Society, for their zealous attention and endeavours to promote the objects of the Society during the past year."

The Society then adjourned.

ADDRESS.

GENTLEMEN,

It devolves upon me again to address you at the close of our Geological year, and recapitulate briefly the subjects which have engaged your attention since the last anniversary. I rejoice that our Society has prospered, and interest in the science of Geology increased.

We meet again, and I hope may often meet, with zeal undiminished, to investigate the truth carefully, proclaim the truth boldly, and correct error gently but unflinchingly.

Our whole object is to arrive at a correct understanding of those wonderful works of nature which surround us on every side, and to the uneducated appear only as outward forms ministering to the sensual uses of man, while to him who looks deeper, they become the sources of manifold intellectual enjoyment—books, in which he may read without tiring the wonderful histories which connect the past with the present, and reveal a constancy of cause and effect, and an unity of purpose which almost lead us into the mysterious depths of the future. There is no difficulty in answering the *cui bono?* question of the utilitarian, for there is not a single art that could flourish without the ministering assistance of many sciences. The genius of the present age appears to be the busy feverish pursuit of wealth; the homes of England are invaded by the extension of railways in every possible direction, and in their rapid current the country is absorbed into the great manufacturing and metropolitan vortices where all the advantages which scientific improvement offers, only seem to swell the profits of the inordinately rich without alleviating the labours or increasing the comforts of the poor. It may be doubted whether that is a healthy state of society where the tendency seems to be to collect the wealth of the nation into a lottery-scheme of a few large prizes and many blanks; but be that as it may, the post of honour is now occupied by the Chemist, the Mechanic, and the Geologist, as far as their sciences minister to the success of money speculations; while, as if to mark that they are courted for their alchymical powers of turning the baser metals into gold, those sciences in which the *cui bono* is not so immediately perceptible are neglected, and we have seen within the last few days botany repudiated from the city of which Roscoe and Currie were citizens. But I am sure that you will agree with me in thinking that there are higher aims connected with the pursuits of science, than individual or national enrichment. It appears

tions; nevertheless, whenever it was possible to use the expe

Q

to me that the love and admiration of what is perfect and pure in the works of nature has been implanted in the mind by Him who creates nothing in vain, as a counterpoise to what is imperfect and gross in the passions of mankind. Who is there, who, when his mind has been agitated by feverish anxiety, has not felt the calm that is produced by looking out on a quiet moonlight scene, or the placid expanse of ocean? and surely that knowledge which gives, as it were, transparency to every object around us, and enables us to see in the solid rock the past inhabitants of our globe, and compare their forms and habits with those of its present inhabitants—that carries the mind out among the rolling orbs that crowd the furthest regions of space, or directs it to the examination of the minutest forms in which the microscope reveals a complex, but beautifully adapted mechanism—that gives to the bird of the air or the flower of the field an interest more engaging than the beauty of colour or the sweetness of song, that knowledge was intended as a wholesome antidote to the all-absorbing passion of gain. Let us, then, look upon the sciences which we are associated to encourage as not only a rest from labour, but as a means of withdrawing our minds from lower objects, and fixing them upon all that has an upward tendency towards the great fountain of truth.

The first paper which was read this year was one by Dr. Apjohn on the composition of certain zeolitic minerals. To the first of these, which appears to have been unnoticed by previous authors, he gives the name of Verrucite. The second, which he states to be identical with the specimen described by Captain Portlock, under the name of Laumonite, with a doubt as to whether it did not approach more nearly the character of Stilbite, (Report p. 744) and analysed by Dr. Thomson of Glasgow, gave a very different result to Dr. Apjohn. It contains less alumina and lime, and more silex than the laumonite, and he has named it Para-stilbite. The third analysis confirms an observation previously made by our Secretary, Mr. Oldham, that the Lehuntite of Dr. Thompson is only a very slightly modified form of Natrolite. Such accurate determinations of the constituents of minerals are most valuable, and I think it is not too much for us to hope that a more perfect understanding of the mode in which the minutest change in the proportion in which the same constituents combine, occasions a constancy in the change in the forms of crystallization, and other mineral characters, may lead eventually to the establishment of some more general laws, and a greater simplicity instead of a greater complexity of arrangement into which the multiplication of new species appears to be leading us.

The next two papers followed each other in continuation of the same subject—"Mr. Mallet's Theory of Glacier Motion." Mr. Mallet, in these papers, combats the idea put forward by Professor James Forbes, Professor Gordon, and others, that ice is a plastic body, and

that to its plasticity is to be attributed the power which the glacier has of "moulding its mighty mass to the sinuous and unequal, or occasionally narrowed portions of the glacier bed." Mr. Mallet supposes that plasticity cannot exist in a crystalline body, which the experiments of Doctor Brewster appear to have left no doubt that ice is. Mr. Mallet believes that every condition for which the theory of plasticity is required would be fulfilled by his supposition, that the great mass of ice is fissured in every direction, and that the particles moving freely on each other, give it a power of adapting its general form to the suggestions of external impulse. Among the causes of motion, he still (as he did in 1838) puts forward prominently hydrostatic pressure exerted by the columns of water, which fill the fissures upon the subglacial streams—an idea which seems to be rejected by Professor Forbes and Mr. Hopkins. The Society must feel greatly indebted to Mr. Mallet for the clearness with which he explained the whole state of this interesting controversy, and will watch with anxiety the establishment of the truth by future observers. To me it seems, that Mr. Mallet has succeeded in proving the agreement of each of his positions, with the known laws of mechanics.

The next subject that engaged the attention of the Society, was the gravel beds that cover so large a portion of Ireland. In June, Mr. Oldham extended the list of fossils which have been found in the clay and gravel deposits in the neighbourhood of Dublin, to the number of twenty-six species. Mr. Oldham has been the first observer who has recognised a pleistocene character in this formation; and it is not improbable that he may yet be able to distinguish more than one period of deposit among those deep and widely-spread accumulations of detritus. In November, Mr. Mallet took a bolder flight; and reserving the proofs upon which he rests his theory for a series of future papers, has announced his intention of accounting for all the phenomena which have so much puzzled Geologists connected with the "transport of boulder gravel and erratic blocks, and the scratching and furrowing of the subjacent rocks, upon the hypothesis of forces and motions known and ascertained to have been in action, either at intervals or constantly, without the need of calling in either great waves, deluges, or inundations in cataclysms, producing the so-called northern, or any other drift, or of ice periods, and the transport of vast masses of matter by such inadequate means as icebergs afloat or glaciers." Mr. Mallet has opened a wide field for discussion, and we shall look forward with interest to his explanation of his theory and its proofs: for this we can clearly see, that every theory as yet advanced has failed in sufficiency to account for the phenomena; and the only hope we have of seeing the problem solved satisfactorily, is in the application of the statical and dynamical laws with which Mr. Mallet is so thoroughly versed. In connexion with the same subject I may now refer to a paper recently brought before you,

tions; nevertheless, whenever it was possible to use the exper

Q

from Mr. Nevins of Waterford, in which he suggests the idea that many of our mountain lakes owe their form and the character of abrupt precipices on the mountain side, and low barriers on the side of the plain, enclosing deep vallies filled with water, to land-slips on a gigantic scale, rather than to the accidents accompanying the elevation of the mountain chains. Accurate details of the position of the strata around these lakes would be necessary to the establishment of Mr. Nevins' view as correct, and I hope that he will undertake to examine further, and communicate to us upon so interesting a subject.

Mr. M'Adam, of Belfast, communicated some interesting observations upon the occurrence of the Lignite, or wood coal, near Belfast; the result of several borings, with a view to ascertaining whether this coal could be made available to any useful extent, led him to the conclusion that the quantity is in that locality very inconsiderable, and that it seems to occupy a small hollow or depression in the trap, which is the surface rock of all that district. The age and distribution of these woody deposits are far from being well understood, and would amply repay a more extended inquiry.

In noticing a brief communication to the Society by Mr. Andrews, upon the connection between the failure in the potatoe crop and the soil in which it grew, I have only to point out, as I did before in my last address, the very great advantages which would result from a more accurate study of the connection between the soil and the plants most suited to it. Nature points out clearly to us, that each plant has a particular soil to which it more easily attaches itself; yet, how apt the farmer is to apply one system under all the varying circumstances which occur. Under pressure of the heavy misfortune which has befallen us, the country applied to the Chemist and the Botanist, as to Physicians who were to describe the disorder and suggest the remedy; but Chemistry and Botany were found to be completely at fault, and the recommendations suggested by science proved to be inconsistent with the ascertained result of practice. Where was the fault? It was that science was taken by surprise—was asked for an opinion and gave it, built upon theory untested by experiment, and the opinion was valueless; but let us hope that science may apply herself to the diligent study of the connection between the growth of plants and the soil—the geology of the country—and we may yet hope that our mode of treating nutritious plants may be much improved, and attended with less risk of failure.

In December last Mr. Mallet read a very ingenious "explanation of the true nature of the assumed vorticose motion, hitherto supposed to accompany earthquakes."

As early as 1755 it had been observed, that the effect of earthquakes was not only to throw down buildings, but sometimes to turn portions of them partially round. Subsequent authors, including Mr. Lyell and Von Humboldt, have attributed these effects to a

vorticose motion given to the earth during the earthquake. Mr. Darwin accounts for them by an analogy with pins and small fragments arranging themselves upon a sheet of paper, to which a vibratory motion has been given. Mr. Mallet considers that neither of these explanations are satisfactory, but that the phenomena of twisting could be readily accounted for on the established principles of mechanics, without having recourse to either vortices or vibrations. His theory is, that when one stone rests upon another, and a motion backwards and forwards, or a simple jerk forwards is given to the lower stone the motion of the upper stone will be determined by the position of its greatest tendency to rest, dependent upon adhesion, gravity, and friction. If the centre of gravity of the upper stone is above its real centre, it would naturally topple over. If the point of greatest resistance to the tendency of one stone to slide over the other happened not to be in the centre of the under surface, the upper stone would naturally assume the appearance of being twisted round upon its base. Mr. Mallet illustrated his paper by the exhibition of models of the pillars of Calabria, quoted by Mr. Lyell, connecting the different members by pivots representing the centres of greatest adhesion, and showed how a forward and retrograde motion produced the effects described and figured by Mr. Lyell. (Principles, vol. 1., p. 482.) We cannot overvalue any of these efforts at reducing geological phenomena to the simple laws of mechanical science. Having thus enumerated the papers relating to the newer formations, and disturbing forces at present in existence, I shall turn to those which relate to the older rocks.

In January last, I brought before your notice some observations on the Limerick Trap Rocks, which have been described so differently by different authors, and to which Mr. Griffith and Dr. Apjohn ascribe the characters of erupted lavas. I have not been able to examine the whole district, but as far as I have examined it, I have laid down my observations on the duplicate maps of the Ordnance Survey, the property of the Society, so that there can be no mistake as to the data, I have reasoned upon, in concluding that the rocks in Limerick may be classified under five heads:—

1st—The Millstone Grit.

2nd—The Upper Limestone.

3rd—The Trap of Knockruagh, Linfield, Kilteely, Herbertstown, and Grange.

4th—The Lower Limestone.

5th—The Traps of Cahirconlish, Syon, Sunville, Templebredon, and the Hill over Kilballyowen.

These latter appear to me to be connected in the strike with the metamorphic conglomerate of Knockfierna, coloured by Mr. Griffith as erupted trap; and I suspect that the lower bed of trap is equivalent to the old red sandstone, and the upper bed to the calp. I do

tions; nevertheless, whenever it was possible to use the exp

Q

not put these views forward as satisfactorily proved, even to my own mind, but every fact connected with these rocks leads me more to the supposition that they have been subjected to alteration after being deposited from water; and I shall look forward with much anxiety to the report of the Government Surveyors, after their detailed examination of the district. We should certainly be slow to admit the alteration of a rock which lies between beds apparently so little altered as the upper and lower limestones are, but we should be as slow in dogmatising against the possibility of it. In the words of Von Humboldt (Cosmos. p. 281, of Trans.) "Where we meet with the slightest glimmer, with the faintest trace of a ray in the obscure regions of mineral formations, we must not thanklessly reject both, because there is still much unexplained in the relations of transition, from one rock to another, and in the isolated position of altered between unaltered strata."

At the December meeting, I read a paper maintaining the views which I had originally adopted in 1837, respecting the position of the rocks occurring to the south of Killarney, from the Reeks to Kenmare, and extending the same view as far as the shores of Bantry Bay.

Mr. Griffith at the January meeting read a paper controverting these views. As at these meetings our differences rested solely upon a difference in observation of facts, and none of the members present expressed any opinion drawn from personal observations, I shall not now enter upon any defence of my own observations, but look forward to the more accurate details of the Government Survey as the tribunal to which our differences are to be referred. When I first made a rough section across that country (and I gave it to you as such, and as mere pioneering work,) I found that Mr. Griffith had coloured the whole of the district as the older clayslate, classifying it with the same rocks which support the conglomerate of the Gaultee mountains unconformably, except that he represented caps of old red sandstone, resting on the summit of the Reeks. It appeared to me that this was not the fact, but that the Reeks formed a great anticlinal supporting the green and red slates which lie to the south, and which again support the mountain limestone. I was, therefore, first to assign to these slates a position above certain beds of conglomerate which had been laid down as belonging to the old red sandstone. Mr. Griffith still maintains that the Reeks form an elevated trough, and that the rocks between them and Kenmare belong to the lowest part of the series there developed. My only reason for using the term Devonian, in the absence of fossils, was founded upon a calculation of the thickness of deposit from the mountain limestone used as a base line, and an analogy between them and other rocks occupying a similar position. Had Mr. Griffith originally placed these rocks in the position he now does, as Upper Silurian, I should have been far from wishing to

draw so fine a distinction, relying upon observations made with a view of merely giving the general features of a country then but little known, and without the help of fossils; but it appeared to me then, as it appears to me now, that the bringing so large an extent of country up to within a few hundred feet of the mountain limestone, and separating these slates from the slate of a much older character with which they were associated in Mr. Griffith's map, was an important correction.

But, gentlemen, let us not allow our thoughts to be occupied by disputes as to the correctness or priority of past observations. Let us sift the truth, and rejoice that the duplicate copy of the ordnance maps, so handsomely presented to us by the government, enables every observer to do as I have done, and to record upon the maps, which are the property of the Society, the actual observations from which conclusions are drawn, so that error may be more easily detected, and imperfections supplied by subsequent observers. For my own part, I know that if I err, I shall be most grateful to him who sets me right; but let us above all things keep looking steadily forward; let me try to impress upon your minds that as yet we know but little of the geology of Ireland. It is an easy task to run lines along the surface, observing here, concluding there, and mapping out the geographical limits of granite, slates, and limestones; but questions of deeper interest ought to engage our earnest attention, if we would aim at aiding in the task of decyphering the history of our globe as written in the sequence of geological phenomena; let us begin with our own island, and not rest satisfied until we have collected all the facts from which we may deduce the changes which it underwent before and after it

"arose from out the azure main."

Let us look upon the titles given to formations, not merely as indices of relative position and age, but as evidence of periods during which we may suppose that the outward form of the earth remained for a certain time comparatively quiescent. We know that the older palæozoic rocks tell their story of a time when the waters covered the earth, and the living types of animal and vegetable life were such as we may suppose to have inhabited a deep sea. These older rocks appear to have been subject to great convulsions; they were broken and torn up, as is commonly supposed, in consequence of contraction in the substance of the globe, gradually diminishing in temperature: every change in the elevation of these rocks must have produced a change in the character of the earth's surface, and the subsequent deposits.

The rocks of the carboniferous age tell their story, too, of sea beaches with their rolled pebbles, of coral reefs and reedy jungles, the forerunners of that luxuriant land vegetation to which we owe our vast beds of coal. As we ascend in the series, we find a

tions; nevertheless, whenever it was possible to use the experi-

succession of deposits of a more local character; but it is to these earlier formations that our attention should be more directly addressed, as Ireland affords such opportunities for their study. To us are given, as it were, the first pages of this old manuscript to unfold and decipher.

I have no doubt, but that as geology advances, great changes will take place in the classification of rocks. Until the last few years the distinction between Cambrian and Silurian was supposed to be sufficiently clear; but Professor Sedgewick, who had been working from below upwards, and Mr. Murchison, who had been working from above downwards, found that they had so far encroached upon each other's systems, that it came to be a question whether Siluria should swallow up Cambria, or Cambria Siluria, and the distinction will probably not last long. The old red sandstone has also by these geologists, and Sir Henry De La Beche, been extended so far as to include a variety of slates and conglomerates, which have been united together under the name of Devonian. It is to the study of these rocks that the south of Ireland appears to open so wide a field; and it is probable that the association of coarse red conglomerates with coralline limestones, extending from the south-east to the south-west, from Cahirconree along the Gaultee and Slievenaman ranges, to Thomastown in Kilkenny, the development of purple and red slates in the line of the Reeks and Knockmeildown chains, and the occurrence of thinner beds of nonfossiliferous and slaty limestone in the valleys of Kenmare and Middleton, may lead us to the conclusion that in approaching the south we are approaching rocks that owe their origin to a deposit from a gradually deeper sea, and that the carboniferous slates of Mr. Griffith may be merely the deep sea equivalents of some of our northern coralline and shelly limestones. Let us ask these questions respecting every bed of rock in Ireland.—What was the position of the rocks previously deposited at the time of its formation? What was its then relation to the level of the ocean? More accurate admeasurements of the dips where different rocks appear in contact, may enable us to trace a degree of elevation in one when the other was horizontal, and thus we may arrive at the chronology of gradual and sudden elevations. But while we thus neglect no means of establishing the order and accidents of superposition, let us diligently seek also to classify these rocks according to the medals of creation that lie imbedded in them. Let us not imagine that the colouring of a map is a matter of mere geological taste. In the very district of the south of Ireland, which I have alluded to, we have seen in a few years the whole extent changed in Mr. Griffith's map from the older clayslate to silurian; and then again in Mr. Knipe's beautiful map it has been, under the authority of Messrs. Murchison and Phillips, coloured as old red sandstone. The period during which these rocks were formed must have been a long one. There must be many a story

attached to it—many an epoch characterised by some change of circumstances, and we should indeed stop far short in geological research were we to rest satisfied with the correctness of any one of the maps I have referred to.

There is one subject connected with the publication of maps and papers to which I shall briefly advert. I wish, before leaving this chair, to put upon record my opinion of the great importance of adhering to priority of publication, as establishing the only claim which an individual can have to the honour attached to priority of discovery.

The advantage of a division of labour in promoting the progress of any science can only be fully felt when each fact announced by the discoverer, and examined into, and found correct by those engaged in the same pursuit, is handed into the common stock, and becomes a starting point for new discoveries. Each stone in the edifice is marked with the name of the contributor; and even when the architectural outline shall have been completed, and the eyes of future generations shall be fixed upon its polished columns, and highly finished capitals, the courses of the foundation will remain visible in the order in which they were laid. I have endeavoured to adhere as closely as I could to priority of publication, in noticing the works of previous authors, and regret that on the occasion when I had last the honour of addressing you, my allusion to the map published by Mr. Weaver, in the Geological Transactions, Vol. 5, should have required any correction by Mr. Griffith.

I had not before an opportunity of making the explanation which Mr. Griffith required, in a letter addressed to me immediately after my last address, containing the following words:—"Perhaps you are not aware that I constructed a Geological Map of Ireland, and exhibited it at my lectures as early as the year 1814; that in 1816 I coloured Arrowsmith's map, on which the general features of the granite and slate of the counties of Wicklow and Wexford were laid down, similar in general outline, though not made out in detail, as at present. Mr. Weaver attended my lectures, and saw this map for several years before he constructed his own. I do not say he copied mine; but the outline was prepared for him to correct, and he did insert several details which were not in my original map. My present Geological Map of the east coast of Ireland differs in several essential particulars from Mr. Weaver's, both as to the outline and to the relative position of the rocks, and *mine I know is correct;* so that it cannot be said that Mr. Weaver either originated or completed the Geological Map of the east of Ireland." It is fair towards Mr. Griffith that I should give his own statement; but I think the Society will absolve me from the charge of unfairness in not having taken a map which was not published, and which I never saw, instead of Mr. Weaver's map, as the first record of the geology of that country. I have followed Mr. Weaver's steps in a

the nature of [illegible]
tions; nevertheless, whenever it was possible to use the expe

Q

great part of that country, and although I differ from some of his conclusions. I always found his descriptions to be most accurate, and to have been founded upon careful observation. I have practical evidence that he was no copyist. But let it not be supposed that in combating Mr. Griffith's assertion—that he "knows his map to be correct"—I undervalue what he has really done for geology. Many a well-chiselled and accurately-fitted stone may be laid over the ruder masonry of the foundation that he has laid without derogating from its value. My sole object has ever been to combat what I know to be the fatal tendency of such assertions—to damp enterprise, and hinder the progress of science.

I hope, gentlemen, that since I have been called to this post of honour, I have looked far beyond the petty desire of establishing the accuracy of this observation, or the inaccuracy of that. I felt that the interests of geology were at stake; and when called upon by the Master General and Board of Ordnance to proceed as your officer to York, to meet the President of the Geological Society of London, and the Professors of Oxford and Cambridge as referrees, to consider a letter addressed to the Chancellor of the Exchequer by Mr. Griffith, who has the direction of the land valuation department in Ireland, proposing to place the government in possession of certain geological information, and requesting an opinion upon "the merits of such information, and how far it would supersede the extension of the Ordnance Survey into Ireland," I felt that the tendency of Mr. Griffith's representations were to deprive the country of the inestimable value which we must all attach to such a work, as I shall have occasion presently to allude to; and that even at the risk of offending an old and valued friend, my duty to you and to science required that I should boldly express my own opinions. And now that I have rapidly glanced over the proceedings of the past year, let me say a few words respecting the future prospects of Irish Geology, and a few points of inquiry to which I would beg to direct the attention of the Society.

I received yesterday from Sir Henry De La Beche a letter announcing the gift to this Society, by Her Majesty's Government, of the sheets of the Geological Survey of Great Britain, which have been already completed, and announcing that all the maps of the Geological Survey of the United Kingdom will be forwarded to the Geological Society of Dublin as they become ready for publication. Now, gentlemen, I cannot express to you too strongly the pleasure I feel in making this announcement. The maps now lie upon your table; you will see from them the character of the work, and will rejoice with me that the government did not see in the correctness of the previously published maps any reason for superseding the extension of this great survey into Ireland. But even when these are completed, shall we rest satisfied that geology has finished her work in Ireland? Far from it. Believe me that the

Government Survey will still leave much to be done by the members of your Society, and that the interest in Geological speculation will have accumulated with the accumulation of data to reason upon.

Let me urge you not to lose the opportunities of collecting facts—simple facts. Even this is a more difficult matter than those who are not in the habit of observing may imagine it to be, to prevent the mind from dwelling more upon the circumstances which seem to connect themselves with a disputed point than those which at the moment may appear to have no bearing upon it. How often has the geologist, when sitting down to plot from his field book, had occasion to regret bitterly that he had neglected to record some fact which would have supplied a link wanting in the chain of his argument. An observer ought to accustom himself to note down every circumstance, and this information may come to be of use to him years afterwards, when he least expects it. The elevation of a mountain chain, and the super-position of the rocks which compose it, are facts which may be collected at any future time as well as the present; but there are among strata the position of which involves equally interesting problems, opportunities of observation which occur once, and if not seized upon by some careful observer, may never occur again, and so be lost to science; for example, railway cuttings probably disclose many interesting sections of our gravel-beds; and when the slopes are finished, these sections will be obliterated, and should at once be recorded. The sinking of our great watercourses, such as the Boyne, Blackwater, &c., may be the means of extending our ideas, as to the transporting power of water and the nature of alluvial accumulations.

And now, gentlemen, I conclude, thanking you for the honour you have done me in placing me in this chair, in which I wish that I had been able to bring more leisure and more knowledge to your service. It is with great pleasure that I see in my successor one who has trodden the deeper paths of science, all closely connected with the study of geology—one who has contributed so much to the interest of your proceedings, and one whose position as a citizen illustrates so well the connexion of science with the useful arts.

the nature of geology, ... the staple of its investi-
tions; nevertheless, whenever it was possible to use the exp

JOURNAL

OF THE

GEOLOGICAL SOCIETY OF DUBLIN.

VOL. III. PART III. 1846. No. 2.

MARCH 11th—"On some secular and diurnal motions of the earth's crust, &c. with a reference to a communication from Sir Wm. R. Hamilton, Professor of Astronomy, and Astronomer Royal of Ireland," by Robert Mallet, Esq. Mem .Ins. C.E. M.R.I.A. President of the Society.

THE PRESIDENT said, that on taking the chair for the first time, he could not better mark his sense of the great honour which the Society had conferred on him in electing him their President, than by laying before them a plan which he had for some time conceived for the organization and carrying out of arrangements for a great, combined, and comprehensive movement for the promotion of a particular branch of geological discovery.

Geology might be divided into topographical and physical, both of which require for their study and development, the confluent aid of several distinct branches of natural inductive science, as well as of the exact sciences properly so called. Physical geology, again, might be divided into several distinct branches, for the cultivation of all of which, the application of Physics, Mechanics, and Chemistry, in their largest senses, is indispensable. For a considerable period it had appeared to him that one of the most important directions in which physical geology could be advanced was, in placing it in connexion with a mode of investigation, new as respected geology, although old as regarded other sciences, namely, measurement; by the organization and solution of such questions as were capable, in terrestrial physics, of having an answer in measure, number or weight. The application of measures to geology might be called experimental geology—a branch of the science hitherto, he might say, unexplored. Geologists had hitherto contented themselves with observing what nature had presented to them, and that must, from the nature of geology, at all times form the staple of its investigations; nevertheless, whenever it was possible to use the experi-

mental method, it might be pronounced not only as the most certain, but also the most rapid, means of advancing geological, as it had always been of every other branch of physical science. In order to illustrate what he meant by measurement in geology, and to show its feasibility, and even simplicity of application, and to what important consequences it at once led, he would briefly give an example of the sort of enquiry alluded to. Taking any large island, such as Ireland, let them suppose the following data respecting it to be obtained in measures—the entire amount of water annually discharged into the sea by all its rivers, and the entire amount of soluble and suspended matter carried down to the sea by them, and the chemical constitution of these. From these data they should be able to pronounce on the amount and on the character of deposits annually taking place round the coasts. They should then be in a condition, with the assistance of their tidal and other knowledge to predicate with a considerable degree of accuracy the nature, character, extent, form, and relative locality, of the deposits so taking place; and hence to predict what forms of rock would at a future period be most likely to occur round their shores; to draw direct conclusions from thence as to the changes in progress, or hereafter to occur, to animal and vegetable marine organization on our coasts; to indicate by the most ample and certain data the changes of soundings, of shoals, of harbours, beaches and bars, which concern the Mariner and the Civil Engineer; and to draw conclusions as to the relation and balance between the wear of the land by detrital action, both meteorogical and tidal, and its replacement by forces of elevation, whether slowly or convulsively.

He mentioned this as one instance of experimental geology; but the direction in which he was at present anxious to have geology advanced, by obtaining the aid of a co-operative movement in applying this method of investigation, was rather different. It had become certain of late years that the crust of their globe, far from being of that immovable character which was popularly supposed, was, in fact, one of the most unstable and changeable parts of creation, that there was nothing immutable upon it, but the very mutability that marks and agitates it, was subject to almost continual motion in both a vertical and a horizontal direction; the latter resulting, at uncertain intervals, principally from the cause which produced earthquakes, the former occurring at occasional epochs from the same cause; and regularly recurring, in all probability, in the form of annual and daily motions of expansion and contraction in the earth's crust, due to alterations of temperature by changes of season, and of day and night. To measure these motions appeared of the very highest importance, at the present epoch, to the advancement of geology. A communication from Sir William R. Hamilton, which he (Mr. M.) had in his hand related to one of these phenomena; but to take

matters in the order of their relative importance, they should first consider these movements which related to the earthquake oscillation of which he had spoken.

It would be necessary, in order that the Society might understand his meaning, and see more clearly the bearing of the motion as to scientific co-operation, which he intended having the honour of laying before Council at a subsequent period, to detain them with a slight sketch of the movements due to forces of elevation and depression which were known to be always taking place in the earth's surface.

That any portion of the earth's crust was absolutely permanent as to level was uncertain; that there were some portions which were neither rising nor falling with respect to an assumed plane, at a fixed distance from the earth's centre, was possible; but that large tracts were slowly rising, and that others were periodically caused to rise; again, that other large tracts were slowly sinking (for instance the great coral region of the South Sea) and some suddenly depressed, (usually at periods of sudden neighbouring elevation,) was certain. The forces which produce these changes of level also give rise to earthquakes. It was necessary for him to refer, very briefly, to some particulars respecting the subject of earthquakes, on which he had recently the honour to lay a paper before the Royal Irish Academy. Every earthquake was in fact a succession, or a combination rather, of waves taking place in the solids forming the crust of the earth, and in the fluids incumbent upon it, and resulting from a rupture or disturbance occurring at some one point of that crust. If they supposed an earthquake taking place under the sea, three sets of waves started at the same moment from the centre of rupture. One of these was the wave of elastic compression, which was propagated in every direction, and was transmitted with a velociety proportioned to the varying elasticity and density of the crust. The passage of this wave constitutes the true earthquake shock. There was also a wave of sound transmitted through both the solid and the liquid portions of the earth's surface, and also a wave of sound transmitted through the air by the impulse communicated to it from the first-mentioned waves; and last of all, the great sea wave, produced by the commotion at the bottom of the sea, which reached the land long after the shock itself had passed it. Here were three classes of motion, which in general were talked of as connected with a very formidable phenomenon, but seldom viewed as movements capable of measurement. It was a fact, that no matter where an earthquake took place, the wave of elastic compression which was produced actuated every portion of the earth's crust, and its occurrence could be detected, by sufficiently accurate instruments, at any part of the globe.

In some of the observatories connected with the great magnetic

survey, now in operation at various points over a great portion of the whole world, and in the organization of which our fellow-member, Dr. Lloyd, has had so large a share, there existed a necessity for certain magnetic instruments, which were, in fact, though not intentionally so, ready-made seismometers: and in the magnetic observatory of Dublin, Dr. Lloyd has frequently observed a sudden vertical oscillation communicated at the same instant to all the instruments, and which he believes to be the effect of slight earth tremors, propagated from remote centres of disturbance.

It would be of the highest service, not only to physics in general, but also to geology, if the circumstances of earthquake shocks could be observed and their velocity measured; since, if they could tell the velocity of the wave through the earth's crust, and were at the same time to determine by proper experiments, the elasticity of the superficial rocks of the earth's surface, they should be able to infer, from the two data so obtained, the nature of the geological deposits under the bed of the ocean, concerning which nothing whatever was known at present. Topographical geology as yet extends but to a small portion of the land; future examinations may embrace the whole of this. But of the nature and boundaries of the formations which compose the bed of the ocean, we know absolutely nothing; so that in fact, two thirds of the whole surface of the globe is in this respect a geological blank. The method of investigation here proposed, however, although it may not give us minute information as to the character of the ocean bed, will enable us to gather some general and certain knowledge of the architecture of those fathomless abysses of the ocean, which no eye can ever behold. He would, therefore, hereafter by the aid of Council ask, perhaps through the medium of the General Council of the British Association, that all the observatories in connection with the magnetic survey should, in addition to their magnetic observations, record observations as to the occurrence of earthquake shocks. This might be very readily done, since the magnetic instruments at present in operation in some of the observatories were quite adapted to afford the necessary indications with respect to the shocks, and other instruments required might be easily added, namely, those which it will be necessary to contrive to register the altitude of the crest of the wave of elastic compression, at the moment of its passage—an element in this enquiry of the first importance.

But it happened, that magnetic observatories which were furnished with these sorts of instruments, did not generally exist in places in which earthquakes were frequent. It thus became necessary to establish in some places, at least, observatories specially devoted to geological purposes as their primary object. It would be highly desirable to have such observatories in the volcanic regions of South America—the land of earthquakes; since, in addition to observing the velocity of the shock wave, the elasticity

of the neighbouring rocks, through which the shock had passed, could experimentally be determined. He conceived that it would be quite possible to get observatories established there, and he should submit to the Council the means by which such a desirable object could most probably be accomplished. Shocks of earthquake were of greatly more frequent occurrence than was generally supposed, and occurred in every part of the world. Violent ones, producing destructive effects, and which were only experienced at limited distances from the centre of disturbance, were comparatively rare; but minor shocks were of almost daily occurrence; and, indeed, in a district in Scotland, the number of such slight shocks occurring within a certain period had been observed. The proposed observatories, therefore, will be by no means unprovided with work.

There was another class of motion to which the earth's crust was subject, and to which Sir William Hamilton's note related. Before reading it, he (Mr. Mallet) might perhaps mention that as much as four years ago, upon an occasion of his dining in company with Dr. Robinson, Astronomer Royal of Armagh, he mentioned to him, (Mr. Mallet) and others, that the observatory of Armagh had been observed to be subject to very slow and minute annual motions, not only to one which was manifested by the whole observatory being lifted in summer and depressed in winter, but also to one by which it appeared to move in azimuth. Dr. Robinson mentioned the fact as one which had not been explained, and it occurred to him, (Mr. Mallet) and he stated at the moment, his anticipation, that it would be found that the motions were due to expansions of the earth's crust, caused by the alternations of temperature of summer and winter. Very recently, conversing with Sir William Hamilton on the subject, he (Mr. Mallet) perceived that a similar idea in connection with it had independantly presented itself to his mind; and, in fact, Sir William Hamilton was to be considered as the discoverer of this class of motion, since the man who first observed a fact, and at the same time gave a true explanation of it, was entitled to the honor of discovery. Mr. Mallet then read the following note which he had received from Sir William Hamilton, and to which he had referred:—

"Observatory of Trinity College, March 2, 1846.

"My Dear Sir,—The only thing which seemed to me original in what I observed to you and others at the geological dinner last month, was the proposition for instituting in new, and multiplying in old, observatories, observations with a levelling instrument, for the purpose of acquiring accurate data respecting some of the expansions, whether periodical or secular, of the crust of the earth. I thought that by fixing the chief attention on the variations of a long spirit level, very carefully and steadily mounted, and from time to time reversed, as in an astronomical observatory, perhaps with precautions as to original erection and subsequent use, which sidereal

checks render not so necessary to the astronomer, and possibly, too, by using two pairs of pillars for two different vertical planes, a gentleman might at a moderate expense of money and trouble make in his own lawn or house observations useful to geology; and if I remember rightly, under this conception I talked of founding geological observatories, on which you remarked, that if your paper on earthquakes had been read to the end at the academy, it would have been found to contain a similar suggestion, though based upon reasons not in all respects the same.

"I also mentioned the fact, that in this observatory, the western end of a transit level, supported on pillars peculiarly favourable for the accurate examination of a point of this kind—(see an account of them by Dr. Ussher, in the first volume of the Transactions of the Royal Irish Academy) —was always a little higher in summer than in winter; and thatin answer to an inquiry of mine, Mr. Cooper's first assistant had by that morning's post informed me that the axis of the instrument at Markree Observatory showed (such as I conjectured that it might) an opposite phenomenon, though this was to be accounted for by mechanical rather than geological consideration. I remember, also, acknowledging that Dr. Robinson had long ago remarked to me that the whole hill on which the Armagh observatory stands is found to have a motion with the seasons, but that I had been in the habit of conceiving Dr. Robinson to deduce this from observations of the azimuth, rather than of the level; and that my own conjecture, perhaps a very wild one, had been, that Ireland as a whole expanded, and thereby rose somewhat more out of the sea in summer than in winter; which expansion, if it were admitted to exist, would account for the western end of the astronomical level rising a little on the east and sinking on the west coast of the Island. Indeed, as a mode of conjecturally accounting for what has been noticed in this observatory, the notion has long been in my mind, and has been put forward by me, though with the necessary diffidence, to some of the astronomical students of the University in one of my lectures last summer, if not at an earlier date. The conversation in which I was engaged with you on this and similar subjects, at the last anniversary dinner of the Geological Society, interested and excited me at the time very much indeed; and if you think the foregoing memorandum, which I have drawn up at your desire, worthy of being incorporated in any communication of your own to the Society, it is perfectly at your service for that purpose.

"I remain, my dear Sir, very truly yours,

"William R. Hamilton."

Mr. Mallet would remind the Society, that the earth's surface was the medium through which two great waves of heat were continually transmitted; one proceeding from the sun, by part of which the atmosphere was heated, and the other coming from the interior of the earth towards the surface. In every climate there was a plane lying between the influences of these two waves, which never changed its temperature, and which varied in its depth below the earth's surface. As there was thus a transmission of heat from the interior of the earth towards its surface, and also from the surface towards the centre, the plane of constant tempera-

ture, or isogeothermal plane as it was called, would be found in any given locality at a determinate depth; and if the supplies of external and internal heat were constant, it would always be found at the same depth in the same place. But inasmuch as the earth's surface was exposed to temperatures, varying with the winter and summer seasons, the level of that plane must rise and fall in proportion to the force of the variable wave. The average depth of this plane in their latitudes was about sixty feet, but was far greater in the tropical climates, in some of which the heating power of the sun ranged to a depth of nearly five hundred feet below the earth's surface.

The result of the varying intensity of the external wave of heat must be the contraction and expansion of the earth's crust due to the difference between the temperatures of summer and winter, and hence a certain annual motion in the earth's crust, besides which, from similar causes, acting in shorter periods, and in less degree, there must be a diurnal motion. To measure this systematically, would be, it appeared to him, highly important, not perhaps directly to those more obvious parts of geology which treat of the elevation of mountain ranges and the depression of valleys, and so forth; but inasmuch as it would lead to a region of investigation which was at present absolutely unknown; and by penetrating which it would be probably be found in this, as in so many other parts of terrestrial physics, that forces and motions the most minute, and scarcely to be detected, when taken in aggregate, were essential and potent parts of the universal machine. There had yet been no investigation of the rate of expansion of any rock, the tables of the rate of expansion of the very few solids hitherto published, having reference only to substances which were of value to the astronomer or the engineer. Therefore with respect to the measurement of these motions, the facility with which the observations necessary for that end could be made, and the likelihood of important information being obtained in the pursuit of it, were grounds sufficient to warrant an undertaking of the object. He had now said sufficient to put the Society in possession of the nature of the views he entertained with respect to the opening in a new region of a new campaign in geology, if he might so speak; and which he hoped to do by inducing his fellow-members of the Council to communicate with such members of the great magnetic body as were connected with Dublin—as, for instance, Professor Lloyd—and through them to the Council of the British Association, to enable certain experiments as to the elasticity of the earth's crust to be made, and the velocity of the elastic wave through it determined; to induce hereafter observations to be made in all the magnetic observatories, (and possibly some new geological observatories founded) and observatories continued, both during the continuance of the magnetic survey and after it had terminated, for the use of the geologist, viz., observations of all the motions, whether diurnal,

secular, or cataclysmal, that take place in the earth's crust. He believed that such observations would be replete with interest to geology and to physics; and he conceived that the application would be met by the British Association with that ready response which had always been given by it to every project that seemed to be calculated for the benefit of science.

"Brief description of the Coast in the vicinity of Kilkee, Co. of Clare," by George V. Du Noyer, Esq. illustrated by drawings.

The author's communication was principally confined to a description of several drawings and sketches of the coast, which exhibited its structure, and the peculiar mode of degradation which has given rise to the many islands along that shore. To these islands characteristic names have been given in Irish, as Illaunawhilla, or the Island of the gulls; Illaunpoulfouhy, or the Island of the horrible chasm; Illaun-asp-magurtha, or the Island of the niggardly Bishop. On the last of these are the remains of a small stone roofed chapel, and some circular stone roofed, or "bee hive" houses. The island must have been materially altered in form and outline since the erection of these buildings, (probably in the 5th or 6th centuries;) and the author supposes that great slips, partly caused by the shaly character of the rocks, may have chiefly tended to produce this alteration.

Northwards from Kilkee is a promontory, called Gattaphilenatraw, or the Gate of the cavern of the strand; and near it is an isolated rock, called Grain rock, or the rock of the sun, a name which it got from its position, such as always to allow of its catching the rays of the sun, and never being in the shade of the adjoining cliffs. This is pierced at some elevation above the sea.

At the small fishing harbour of Gouleen there is a beautiful example of a synclinal ridge, the rocks on one side of the Bay dipping to the south, and on the other to the north, while the cliffs at the land give a natural section of the contortion. The name Gouleen, in Irish means the little fork of the sea, comparing the rocks which jut out on either side of the harbour, to the outstretched legs of a man.

Many cases may be seen along the coast, in which the rocks have been very much contorted; and in some, as between Doonderilleroe and the puffing holes of Ross, where the forces applied have fractured the softer beds into an acute angle, while the harder and more unyielding have merely been arched.

The rocks along this coast consist of detached portions of grit, resting on black shale, beneath which is a compact silicious sandstone, approaching in many instances to a quartz rock; between which and the shale there occurs a thin bed of impure limestone, containing shells and encrinite remains.

"On *Griffithides globiceps*, Portlock, and some other Carboniferous Limestone fossils," by Professor Oldham, Secretary to the Society.

In many cases fossil species have been established from an examination of only a single, and often a mutilated specimen, and descriptions, thus derived from fragments, have been subsequently referred by other authors to totally different species. In some instances it is easy to detect such errors, as the specimens referred to were figured; but in others, where this precaution was not adopted, there was very considerable difficulty in ascertaining how far the descriptions of different authors referred to identical species. When this arises from imperfect descriptions or drawings on the part of the first noter of the species, the only effectual means of removing the confusion appears to be by again, and from more perfect specimens, figuring and describing the same species, having the identity established, if possible, by the original author. It seems, therefore, desirable from time to time, as opportunity should offer, and as materals are procured for the purpose, to publish descriptions and figures of such species, as appear to have been imperfectly described, since a greater benefit results from the accurately defining one known species, than from the establishing of several new ones. With this view, I have now brought under the notice of the Society a few specimens.

One of the most abundant trilobites of the carboniferous limestone is the *Asaphus globiceps* of Phillips, who was the first English author, (Geology of Yorkshire, 1836, Vol. II. page 240, Pl. xxii. fig. 16—20,) to figure and describe the species, referring it provisionally, together with all the other trilobites from the same formation, to the genus asaphus. The same species probably, though this does not seem certain, was figured previously in 1825, by Fischer; and again in 1837, (Oryc. du gouv. de Moscow, pl. xii. fig. 26,) and by several other continental authors. In 1843, Portlock in his Geological report on Londonderry, &c., reviewed the whole group, and established for the reception of those mountain limestone trilobites, previously referred to Asaphus, two new genera, *Griffithides* and *Phillipsia*, of the former of which the *Griffithides globiceps* may be considered the typical species.

Notwithstanding, however, that numerous authors have quoted this species, there still appears some considerable discrepancy between their descriptions. Phillips describes it very briefly thus, "Limb quadrate, with four imbricating striæ; eyes lunate on a globular projection; head globular." Portlock, (page 311) referring to the point noticed above, says, "the wings end posteriorly in sharp angles, and in perfect specimens appear strongly striated." De Köninck (Hist. des Animaux fossiles, &c., page 300) says, "rim ornamented with seven or eight small longitudinal furrows,"

and Mr. M'Coy (Synopsis of Carb. Lime. Foss. of Ireland, page 160) says, "wings broad, convex, with strong imbricating, longitudinal striæ." Again in other respects there is an equal difference. M'Coy says, "entire surface smooth," De Kōninck, "entire surface covered with small irregular granulations only visible with a lens." From these and several other such differences, it is evident that there has been some confusion arising either from individuals belonging to different species, having been under description, or of the same species, in different states of preservation; while none of the authors who have figured it, appear to have been possessed of perfect specimens. That figured by De Kōninck (pl. liii. fig. 1) is certainly not of this species.

It seemed, therefore, desirable briefly to describe the species again from more perfect specimens than have been previously figured, having first taken the precaution of establishing their identity, by a reference to the original describer, Professor Phillips.

Asaphus globiceps,		Phillips, pl. xxii., fig. 16—20.
Griffithides,	„	Portlock, pl. xi., fig. 9.
„	„	M'Coy, Synopsis, page 160.
Phillipsia,	„	De Kōninck, pl. liii. fig. 1.

General form, elongated oval, body contractile, divided into three nearly equal parts by the cephalothorax, thorax and pygidium; entire surface, marked with minute irregularly disposed granulations; these are only seen in well preserved specimens. *Cephalothorax* semi-elliptic: *glabella*, short, pyriform, very tumescent, approaching to globular in front; (figs. 1, 2, 9, 10, 11, pl. ii.) considerably elevated above the cheeks, narrowed behind to about one half its breadth in front, the tubercles or projecting portions which connect the eyes with the glabella forming the remainder of the breadth; divided from the cheeks by well marked furrows; it is marked by three nearly obsolete cephalo-thoracic furrows on either side; these are scarcely seen when perfect, but are obvious in the cast; cast minutely punctured or granulated. *Cheeks*, spherico-triangular, convex, so thickened on the outer edge as to form a distinct border or rim, elevated above the cheeks and rounded, which is prolonged backwards into short pointed spines, (fig. 9, 11; they are broken off in fig. 1.) This rim or border ("wings") is marked with sharply raised longitudinal lines, the number varying in different specimens, and in different parts of the rim, as they do not extend the whole length, (our figures are deficient in showing this.) These raised lines are wanting in the cast which is smooth. The raised rim is continued across the cephalothorax, where it joins the thorax, and is here of the same form and structure, as the first transversal segment of the thorax from which it is sometimes not easily distinguishable. In front of the glabella, the rim is much smaller than along the margin of the wings, and is turned under the margin, forming a flat expansion as seen in fig. 10. *Eyes*, small, suboval, very prominent, when perfect covered with a smooth corneous

transparent membrane; but under this very finely and beautifully reticulated, (fig. 7, pl. ii.) not oblique; (the apparent obliquity of the eye being caused by the position of the tubercle or projection which unites it with the glabella,) covered above with a distinctly granulated "velum palpebrale, (fig. 6, 7, 8;) the outline of which corresponds to the facial suture. Neck tubercle frequently seen.

In the furrows which separate the cheeks and glabella, about half way between the front of the eye and the anterior margin, I have observed in all the tolerably preserved specimens which I have seen, a small hole or indentation. These are constant, and therefore obviously connected with the structure of the creature, although I cannot offer an explanation of their use. They are similar to those noticed by Portlock in his Ampyx sarsii.

Thorax, joints nine in number; when perfectly preserved the joints of the medial segment or axis appear simple, but are marked internally with a transverse furrow, (fig. 5;) the joints of the lateral segments ("pleuripedes," Portlock) are compound (fig. 4,) being marked along their centre by a furrow, which follows the outline of their form, but does not reach the outer margin; and so formed by flattening on the edge, as to admit of their folding freely over one another, when the animal was contracted, as in fig. 11; the axal and lateral lobes are nearly equal in breadth, but differ much in sectional form, as may be seen in fig. 3.

Pygidium, a little more than semicircular; middle lobe consisting of eleven costæ, divided by well marked furrows, and simple, (De Kōninck says fourteen; our specimens do not confirm this,) which diminish successively: the lateral lobes have about thirteen costæ, simple and united at the margin by a smooth rim, the furrows which divide the costæ becoming obsolete, or nearly so, before they reach the outer edge; this smooth rim occupies about one third of the breadth of the lobe.

When rolled up, this smooth rim partly covers the wings of the thorax, (fig. 11.)

Pl. ii. fig. 1, shows the animal expanded; fig. 2, the same specimen seen in profile.

Fig. 3, sectional outline of form of thorax.

Fig. 4, joints of lateral lobes; fig. 5, joints of axal lobe of thorax.

Fig. 6, 7, 8, eye, seen from above, from side, and from behind.

Fig. 9, head of another larger individual, seen in profile.

Fig. 10, under portion of wings.

Fig. 11, a rolled up specimen.

Fig. 12, eye of Phillipsia, figured for comparison.

Figs. 1, 2, 3, 9, 10, 11, are of natural size; the rest are magnified.

The genera Griffithides and Phillipsia of Portlock are very closely related, and many Palæontologists have doubted the propriety of dividing them; De Kōninck among others suppressed the genus Griffithides, merging it in Phillipsia, and considering the essential generic character to be the presence of the "two small triangular

uberoles," to which he gives the name of "com plementary tubercles of the frontal lobe," and which also serve to distinguish it from the genus Archegonus of Burmeister. Mr. M'Coy considers the distinctions very constant and marked, resting the division, as did Captain Portlock in part, on the presence or absence of the cephalo-thoracic furrows; on the form of the glabella, and the character of the eyes; and Emmerich, (Neues Jahrbuch fur Miner., &c. 1845; and translation in Taylor's Scientific Memoirs, Part xiv.) places the two genera in different families; the distinction of which families he rests on the difference in the structure of the eye, one having granular facetted eyes, and the other, eyes covered with a smooth horny membrane.

We have already shown that the eyes of the *Griffithides globiceps;* (Portk.) the typical species of that genus, are reticulated; the corneous membrane being only present, when the fossil is very well preserved; and in the typical species of Phillipsia, there is also a thin corneous membrane over the reticulation; the greater frequency of the occurrence of the reticulation visible in this genus apparently being due to the greater thinness of the membrane, and the larger size of the reticulation of the eyes. The form of the glabella is certainly an important character, but it varies so materially in species, referable from other characters, to each of the genera Phillipsia and Griffithides,* that it cannot, I think, be considered a good generic distinction, though good as a specific one. And further, the cephalo-thoracic furrows are present in all Griffithides, though certainly not so strongly marked as in the typical species of Phillipsia. In all other respects, which could be at all considered as sufficient for *generic* distinction, they agree; and it therefore seems to me, that there is no sufficient ground for retaining the two genera; and I would agree with De Kōninck in referring all these trilobites to the genus Phillipsia of Portlock.

It is remarkable that M. De Kōninck, in his excellent "Description des Anim. foss. dans le terr carbonif. de Belgique," though figuring (Pl. liii. fig. 1,) a trilobite with strongly reticulated eyes, as P. globiceps, states in his text, in more than one place, and most particularly, that the eyes are smooth. Indeed, although his description is in general accurate enough, his plate represents a fossil, which in many respects totally differs from the Asaphus globiceps of Phillips to which he refers it.

Mr. M'Coy, (Synopsis of Carb. Limes. Fossils,) among the very many valuable additions which he has made to the number of crustaceans previously known from these deposits, has figured and described under the name of *Astacus phillipsii,* a fossil collected at the Hook Point, Co. of Wexford, by Mr. C. W. Hamilton.

* Is Phillipsia cælata of M'Coy, not the Griffithides longiceps of Portlock? The figures and descriptions are not sufficient to decide.

As I have had frequent opportunities of examining this identical specimen, and many others, as I believe, similar to it, and from the same locality, I have satisfied myself that the fossil does not belong to the group of Crustacea at all, but that it is a part of the hinge portion of a brachiopode shell seen from within. The figure given does not very accurately represent it. There is nothing in the mode of preservation or fossilization different from that of the remains of the brachiopoda common in the same locality. I am aware that M. Agassiz referred the fossil in question to the same group as Mr. M'Coy, but this was on a cursory examination many years since; a frequent examination of it since, could show me no ground for this opinion.

The very varied groups of organic remains which have been classed under the genera Gorgonia, Retepora, Fenestella, Ptylopora, &c. have long attracted much attention among Geologists, from the great beauty of their remains, and the perfection with which many of them are preserved; and under each of these genera many species have been described and figured by authors. These descriptions have in numerous cases been drawn from fragmentary portions of the corallines, and however valuable, as provisionally directing attention to the varieties met with, must always be subject to correction on the occurrence of more perfectly preserved specimens; and there appears but little doubt that many of the species, thus formed, must finally lapse. In addition also to mere structure, frequently not well preserved, the habit of growth appears an important element in the distinguishing of such remains, and this can never be ascertained from an isolated fragment. To an instance of this habit of growth which has not been much noticed, I would wish to draw attention: Professor Phillips in his valuable memoir on the mountain limestone district of Yorkshire, (pl. 1,) figures several of these corallines, but apparently in all cases from fragmentary specimens; and his plate (fig. 1,) shows the mode of growth which *Retepora membranacea* appeared to him to have, forming a kind of conical cup springing from a point. Captain Portlock in his report on Londonderry, &c., (pl. xxii. A, fig. 5, A,) figures a specimen referred by him to *Retepora prisca* of Goldfuss, in which its mode of growth from "a round repent stem, which on its cellular surface runs into a strong angular midrib," is shown.*

With these exceptions, the fact of the mode of attachment, and some peculiar habits of growth connected therewith, in the fossils referred

* At the time this paper was read, I had overlooked the fact that Mr. M'Coy, in his useful Synopsis of the carboniferous limestone fossils of Ireland, when describing the Fenestella membranacea, the most common species, says, "it is fixed at the base by long solid non-poriferous roots of considerable thickness;" and I have to thank Mr. M'Coy for directing my attention to the passage. The principal facts, however, that this habit is not confined to one species or genus, nor to the root-like processes at the base, are not noticed.

to these genera, would appear to have been nearly overlooked. I have, therefore, had figured in Plate 3, a few specimens which show this habit of growth tolerably well; in figs. 1 and 2 it will be seen that from the lower portion of the coral, (conical in fig. 1, expanded in a convoluted form, in fig. 2,) proceed root-like processes. These appear solid externally, but on being fractured the pores are still visible, though nearly obliterated, and in some cases entirely so, by the further secretion of the solid matter. These proceed both from the bottom and sides of the coral, as is better seen in Pl. iii. fig. 4, where a portion of a large expansion is shown with the solid lateral processes extending from it. In many cases these are several inches in length; in Pl. iii. fig. 3, another variety is seen, where in addition to the lateral solid processes, the coral has been strengthened, at the points of attachment of these, by the addition of solid matter forming a kind of irregular net-work over the regular cellular part of the coral, thus giving the lateral processes a greater surface of adhesion, and as it were a firmer hold of the coral, by which to anchor it more steadily to whatever it was attached. Many specimens in the author's possession show these growing from the coral, at the distance of nearly a foot from the root or more pointed attachment, and extending for several inches, so that they must have been thrown out by the creatures inhabiting the coral as a means of fixing themselves more firmly, or anchoring themselves from the tossing, and probably destructive action of the sea. These side roots, as they may be called, have not, as far as the author knows, been hitherto noticed. This character is by no means confined to one species, nor yet to that group which are found in simply expanded forms or net-work. But it is also found in those corals which have been referred to *Ptylopora* by Mr. M'Coy, where the net-work is expanded like a feather at either side of the midrib; for in these also the same habit of throwing off side stays, in addition to the root-like stem noticed by Portlock, is seen to occur, as in fig 3, representing part of a large specimen.

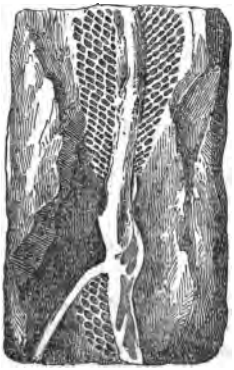


Fig 3.

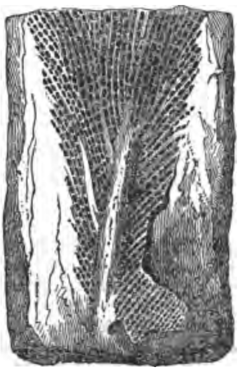


Fig. .4.

It is by no means improbable either, that many of the so called Fenestella of authors had precisely the same habit of growth from a midrib, though not yet seen so. Fig. 4, will show that this character was not constant even in the same species, but that the midrib ceased at a certain period of growth, and divided into several portions larger than the ordinary ribs of the net-work, and which gave to the latter a peculiarly unequal character. If therefore this mode of growth be admitted as a sufficient generic distinction, the same coral would be in one part a Ptylopora, in another a Fenestella. It would appear extremely probable, that both belong to the genus Gorgonia. The illustrations I have given have not been intended to define species, but merely to show *a habit of growth* common to several, and which appears not to have been sufficiently attended to.

Some of these root-like processes here alluded to, when detached, have been considered, and named Gorgoniæ.

Malleus orbicularis—M'COY, Synopsis, page 87, pl. xix. fig. 2. Mr. Oldham stated, that from some specimens, though imperfect, of this shell which had come into his hands, he was led to think that the opposite valve to that figured by Mr. M'Coy was longitudinally striated, and might possibly be found identical with some species already described. This however, along with the inequality of the valves, had convinced him that that author was in error, in referring the species to the genus Malleus, on such slight grounds as he had, "the thickness and irregularity of the foliaceous shell," while at the same time he points out that it differs in form from any known malleus. The reference, without sufficient grounds, of shells found in the palœozoic rocks, to genera essentially confined, as far as our knowledge goes, to more recent deposits, tends much to confuse our ideas of the statistics of distribution of genera and species, and for this reason alone should be carefully guarded against. We do not mean to assert, that a recent genus will not be found in the older rocks; but if in any case, genera still existing, have been found to have existed also during the periods of the deposits of the more recent or tertiary rocks, but are not found in those immediately below, or the upper secondary, there is from this fact alone, very strong grounds for questioning their occurrence in the palœozoic, or older group; and in opposition to such facts, the evidence should be clear and decisive, on which they are admitted. Now such being the case in the present instance, the mere thickness, and irregularity of the shell do not seem by any means sufficient to authorize the reference of the shells figured by Mr. M'Coy to the genus Malleus, hitherto only known in the more recent periods; more especially when in other respects it so obviously agrees with the characters of Avicula, to which there is little question that it belongs. The species will remain therefore, until more perfect specimens be procured having both valves, as *Avicula orbicularis*,—M'COY, Sp.

April 8th.—"On the Geology of the neighbourhood of Lisbon;" by John Scouler, F.L.S. Professor of Geology to the Royal Dublin Society.

The author described the general structure of the district, and directed particular attention to the peculiar fossils, the Hippurites and Birostrites, which he considered as belonging to the same class as the Balani; but as the author is about to revisit the country, the printing of this paper in full is postponed.

May 13th—"Note on the tertiary deposits of the Co. Wexford," by Captain James, R.E.

Captain James in presenting to the Society a list of the tertiary fossils which had been collected in the County of Wexford, during the progress of the Geological Survey last year, confined his observations to a general sketch of the area occupied by the deposits from which they had been collected; they extend from the northern boundary of the county near Arklow, along the whole line of coast, and as far south as Kilmore, and inland as far as Gorey, Ferns, and Enniscorthy, that is, extending about forty miles in length, with an average breadth of eight or nine miles, broken only by the tops of a few hills, such as Tarah hill, Carrickroe, and Oulart hill, which stand up like ancient islands in the midst of the tertiaries. The greatest altitude at which they were found, was four hundred feet, on the side of Forth mountain, and the greatest depth to which they have been exposed, is a hundred and seventy-four feet, near Blackwater, but they do not rest here on any rock and therefore may be of a much greater thickness. It is the presence of these tertiaries which give to the district described its rich agricultural character, and which has contributed to give the Barony of Forth, in particular, the high reputation for the fertility of its soil.

Captain James presented a drawing of the coast at Ballygerey, in the Barony of Forth, where the cliffs are composed, almost exclusively, of a tenacious clay of a dark brown colour; in general appearance, exceedingly like the London clay, and of an average thickness of seventy feet, and which must have been deposited in a tranquil sea, as evidenced by the rows of Nullipora; and in some places, as to the north of Wexford town, by the presence of such delicate shells, as the Fusus bamfius, which are found in the most perfect state, and appear never to have been disturbed.

This great deposit of clay, Captain James considers to be the most important member of the tertiary deposits in Ireland, and he expressed his conviction, that it was but the remains of a far greater

deposit, (preserved by its position, with reference to the Wexford and Wicklow mountains, from the denuding effects of that great current which brought down the northern drift,) which must have extended over the whole of Ireland, and the remains of which have been noticed in so many distant places; but although this is the most important member of the tertiaries, it is not the most ancient. Captain James exhibited a section to show that below these clays there is almost invariably found a deposit of rolled and water-worn pebbles; and that above them, there is generally found a deposit of sand and gravel, and drift, which he considers of the age of the northern drift. Captain James exhibited a large block of coal, found in the clays at Rathaspick near Wexford, at an altitude of two hundred and thirty feet, and which Mr. Griffith considers to be a piece of the wood-coal from Antrim.

List of Tertiary Fossils, found in the County of Wexford, during the progress of the Geological Survey of Ireland.

PLANTS.

Nullipora, polymorpha.

ZOOPHYTES.

Cellepora, pumicosa.

ANNELIDES.

Pomatoceras tricuspis, (Vermilia triquetra.)

CIRRHIPEDES.

Balanus, balanoides,
uddevalensis, (B. Scoticus.)

MOLLUSCA.

(1. *Species still living in the British seas,*)

(*a.* general,)

Venus, cassina,
virginea,
decussata,
fasciata,
Pholas, crispatus,
Solen, ensis? (or siliqua,)
Lutraria, elliptica,
Mya, arenaria,
Mactra, solida?
Corbula, nucleus,
Saxicava, rugosa,
Tellina, solidula,
Donax, trunculus,
Astarte, damnoniensis,
Artemis, exoleta,
Cardium, edule,
echinatum?
Pectunculus, pilosus,
Nucula, nuclea,
Modiola, vulgaris,
Mytilus, edulis,
Pecten, varius,
distortus,
maximus,
Ostrea, edulis,
Anomia, undulata,
Natica, monilifera,
Littorina, rudis,
littorea,
Trochus, ziziphinus,
Lacuna, montagui?
Turritella, terebra,
Pleurotoma, turriculus,
Purpura, lapillus,
Aporrhais, pes-pelicani,
Fusus, antiquus,
islandicus,
Murex, erinaceus,
Buccinum, undatum,
Nassa, reticulata,
macula,
Cypræa, europæa,
Patella, vulgata,

(*b*, in the northern parts of the British seas,)

Astarte elliptica,
borealis, (confined to far north,)
compressa (most abundant in north,)
Nucula, tenuis, (do.)
proxima, (do.)
Fusus Bamfius,
barvicensis,
sabini,
Trichotropis, borealis, (confined to the north,)

(*c*, in the southern parts of the British seas,)

Venus, verrucosa? (The fragments of this are doubtful, and may be the Crag V. turgida or the American V. mercenaria,)
Trochus, exasperatus,
(2. *Species not now living in the British seas,*)
(a. Living in the northern or arctic seas, on coasts of Greenland and Boreal America,)
Nucula, hyperborea,
rostrata,
Scalaria, grœnlandica,
Fusus, fabricii,
Fusus vahlii?
scalariformis,
Natica, clausa.
(b. Living in seas south of Britain,)
Turritella, incrassata,
Mitra, corneus?
Fusus, crispus?
Nassa, semistriata,
(c. Known only as crag fossils,)
Tornatella, pyramidata,
Nucula, cobboldiæ?
And an undetermined species of Nucula and one of Pleurotoma.

The fossils have been named by Professor E. Forbes, the palæontologist to the Survey; it contains seventy-four species, the greatest number previously known throughout Ireland being twenty-six.

Professor Forbes has not distinguished the reversed Fusus antiquus, (the Fusus contrarius of Sowerby, given by Lyell and other writers, as a characteristic shell of the red crag) as a separate species; but Captain James states, that he found the reversed form one hundred to one, more numerous than the other.

This list, with the remarks on the present habitats of the testaceous fauna, it is hoped will be found a valuable addition to our knowledge of the tertiary deposits of Ireland, and help to solve some of the difficult problems connected with the subject.

June 10th—"On the formation of the fissures of mineral veins and dykes," by Robert Mallet, Esq., President of the Society, &c. &c.

The author referred the formation of these fissures to such waves of elastic compression as he had recently attributed earthquake motion to; but the paper having been only read in part, the printing of it is postponed.

"On the supposed existence of Moraines in Glenmalur, Co. of Wicklow," by Professor Oldham, F.G.S. &c., Secretary of the Society.

The glen or ravine, as it may be called, of Glenmalur runs nearly in a right line from N.W. to S.E. for a length of about six miles, from its summit to the old Barrack at Drumgoff, below which it continues in the same general direction, but becomes broader and more sinuous, and loses that peculiar ravine character which marks its upper portion. The sides above the point where the old military road crosses the glen at Drumgoff are steep, craggy, and bare, and this character extends to the end of the glen. Above Drumgoff,

the glen is also characterized by the absence of any lateral valleys opening into it, with the exception of one, extremely wild and beautiful, through which flows a stream, forming the drainage of the waters which fall on the southern slopes of Lugnaquilla. In, and at the junction of this side glen with Glenmalur, are the remarkable ridges of gravel which have been called Moraines, and the formation of which has been attributed to the action of glaciers, and with much greater appearance of probability than in many of those cases where the aid of glacier action has been hastily and unnecessarily called in to account for numerous detrital deposits due to ordinary causes, acting under conditions slightly different from those at present existing.

In the present case, the mountain top of Lugnaquilla might supply the glacier, and the form of the valley, and the outline and position of the so called Moraine are not such as to contradict the supposition; but a little closer examination at once shows it to be untenable. The rocky sides of the glen exhibit none of that wear and undercutting which they would if they had been acted on by a glacier producing such Moraines; the portion of the craggy side of Glenmalur, opposite to the opening of this valley, is equally unworn; while, besides, and in itself sufficient to overthrow the idea of a Moraine, the bank of gravel is regularly stratified, or in successive layers of varying coarseness and character. Up the glen there certainly occurs a large face of polished or smoothed granite; but whoever has seen this glen in winter, or after heavy rains, will remember, that the water falls over the whole of this smoothed surface, carrying with it all the detritus of the upper grounds, and most effectually grinding down the rocks. The very steep inclination of the sides of the glen is sufficient to account for the existence of the large and heavy blocks of granite which occur, and which gravity alone would bring down, if once detached from the upper portions of the sides.

But there is no necessity for resorting to the idea of glacial action to account for such deposits, which seem referable to the ordinary action of water. The position and character of this ridge would point it out as a very well marked case of a valley bar, caused by the deposition of the detritus of the side valley, and also in part of that of the principal glen, which had taken place where the waters of both met, its form being due to the united action of both, tailing it off down the glen. This bar being formed at a period when the waters stood at a very different elevation in the valleys, a lake or estuary was produced inside, and this appears to have forced its way through the barrier at several times, and in different places; the cuts caused by which are still visible, and are altogether distinct, and at different elevations, from the present course of the stream, which has eaten through, and exposed a section of the bank.

The similar ridges in the upper part of the glen are due to similar causes, although it would be difficult to render the exact condition of the case evident without several drawings.

The phenomena of old valley bars may be studied to advantage in this district of the County of Wicklow. Another, though not so well marked, is seen across Glenmalur, opposite the little river at the foot of the glen; and again, on the line of the Cloghoge Brook, between Lough Dan and Lough Tay.

"On the appearances brought to light by the tunnelling operations, at Down Hill, Co. of Derry," by James M'Adam, Esq. Belfast.

Recently two tunnels have been partly completed on the line of the Londonderry and Coleraine railway, at Down Hill, one seven hundred yards in length, the other three hundred, entirely through the trap rocks of that district. The examination of these tunnels fully confirms the observations of Captain Portlock in his report; but some of the phenomena observed in the interior of the tunnels were considered worthy of notice.

At the eastern opening of the longest tunnel, hard masses of trap may be perceived interlaced with soft in the most irregular manner—the soft is more frequently amygdaloidal—the hard occasionally so, and it occurs sometimes in concretions with the surface much ironshot, and peeling off. In some rare cases, the concretions show the appearance of concentric layers, like the onion basalt of the causeway; these last mentioned concretions are also more or less amygdaloidal. The surface of the trap has in some places a rubbly appearance, with hard portions of various sizes mixed with it; in a few places, these portions offer an appearance of regular arrangement.

Occasionally thin seams of ochreous trap are met with. The sides of the tunnels, as left by the workmen's tools, have a rude columnar appearance in the gloomy light in which they are viewed; and in these sides are imbedded vast numbers of minerals of high interest to the student of mineralogy. The grouping of these minerals is rather different from that at the causeway, or in other places, in the County of Antrim. There is very little Analcime or Chabasie to be met with, but immense quantities of mesotype, and a number of the rarer zeolites; for so far, there seems to be no chalcedony in this locality; but there is an unusual quantity of steatite, and splendid calcareous spars, also carbonate of lime and magnesia.

The difference of grouping of the imbedded minerals in different parts of the trap district of the North of Ireland is deserving of attention, and is worthy of future examination. Take the cases of the Cave Hill, near Belfast, of the cliffs of Island Magee, the little Deer Park of Glenarm, the Causeway, and Downhill, and

each locality exhibits a different grouping or assortment of the minerals contained in the drusy cavities of the trap. For this difference there must be some reason, and an examination might bring forth some new scientific information.

The author alluded to a great blast which took place on the 8th of June, when two charges amounting to nearly 4000 lbs., were simultaneously fired by galvanic action.

The result was in the highest degree satisfactory—there was but a very moderate report—the rocks separated into large fragments, and slowly descended to the beach—not a stone was projected in any direction, nor did the slightest accident occur. It may be mentioned, that the chest containing the large charge of powder was at the distance of about twenty-five feet from the opening of the gallery in the cliffs.

The ease with which the mass separated may be explained by the very varied structural composition of the rock itself, which caused a number of joinings or minute fissures, on disturbing which, the cohesion of the whole was destroyed.

JOURNAL

OF THE

GEOLOGICAL SOCIETY OF DUBLIN.

VOL. III. PART III. 1846. No. 3.

NOVEMBER 11th—P. Waddy, Esq. M.D. Articlave, Coleraine; and Walter S. Willson, Esq. Geological Survey of Ireland, were admitted members of the Society.

"Notice of some marine shells, stated to have fallen in the County of Carlow," by Robert Mallet, Esq. President of the Society.

The author having casually heard of the fact, that after a violent thunder storm, during the month of July, in the present year, numerous shells had been found on the surface of a freshly mown field, in Colonel Bruen's demense at Oak Park, near Carlow, and having ascertained the name of the person who had made the observation, he wrote to him, and obtained the following answer:—

"Oak Park, August 7th, 1846.

"SIR,—Agreeable to your letter of the 5th inst. I forward you and your invaluable Society some of the best of the marine shells collected by me, Thomas Lock, July 24th, 1846, after a terrific thunder storm. The morning of the 24th was quite serene; a little change took place about half past 10 to 12 o'clock, A.M.

"I took notice of a little whirlwind, which took some of the short grass, &c. several feet into the air. I remarked to some of my men that it was indicative of storm. At 2 o'clock the air began to feel cold, wind S.E. by E. Storm commenced at twenty minutes past 2 o'clock, P.M. lasted until five minutes past 3 o'clock, during which time we had the resemblance of winter.

"I measured many hailstones 2½ inches in circumference. Feeling anxious about things under my superintendency, as soon as I could I took a walk round, and to my great surprise, on the lawn which the men had been mowing and cleaning up in the morning, I saw an immense quantity of shells laying quite thick for yards around me. I called the attention of many persons to the fact, and all were full of astonishment. In having given you all particulars, as far as I know,

"I am, Sir,

"Your most obedient Servant,

"THOMAS LOCK.

"To ROBERT MALLET, C.E.
President of the Geological Society."

Mr. Lock was steward to Colonel Bruen, and appeared to have noticed the facts with care. He could have no possible object in misrepresenting those facts, and the circumstances were such as to preclude the *probability* of the shells having come in any other way than carried by the force of the storm. The shells certainly were not there in the morning of the same day in which they were gathered, for the grass on which they were found had been close mown and cleaned up, and none seen.

Calculating from the direction of the wind at the time of the storm, the nearest point of sea shore would be the sandy flats of Wexford, where, too, all the shells noticed occur; and which, in a right line, would be distant about forty-five miles.

The following is a list of the shells found, from which it will be seen that they are all common species on these coasts; and mixed with them are a few of the ordinary land shells. The specimens have been examined and named by Mr. R. Ball.

Bulimus acutus,	Cypræa europæa,
Helix virgata,	*Mytilus edulis,
*Venus gallina,	Nucula nuclea,
Littorina rudis,	Tellina squalida,
Littorina neritoides,	Tellina solidula,
Trochus cinerarius,	*Cardium edule,
Purpura lapillus,	Donax trunculus.
Nassa incrassata,	

* The shells marked thus (*) are in a fragmentary condition.

"Notice of the occurrence of a small boss of Serpentine, in the County of Wicklow," by Professor Oldham, Secretary of the Society.

The author stated that during a recent visit, in company with Sir Henry De La Beche, to parts of the County of Wicklow, they had observed about half a mile south of the village of Roundwood, on the road from that village to Glendalough, a small protrusion of a serpentine rock, which offered many points of interest. Standing out boldly in a few detached hummocks, it at once strikes the eye, and on examining it was found to be of very varied composition, passing, by every possible gradation, from a crystalline greenstone slightly diallagic, to a flaky mass, very argillaceous in aspect, of a a deep claret red colour, and having its numerous fissures covered with sleatitic and serpentine coatings of bright green and variegated colours. It is peculiarly interesting as affording, within the short space of a few yards, so many varieties in composition, and which are so easily traceable. It also offers another remarkable circumstance—by no means common, and which has been very rarely observed in such rocks—that it is, in many parts, vesicular, the small air cavities being in the undecomposed parts of the mass,

filled with carbonate of lime. Parts of the mass might be mistaken for slaty rocks of a deep red colour, on a cursory inspection; but this idea will be removed by a closer examination of the country about, where the rocks are found to be of a dark grey colour approaching to black; and besides, the result of the alteration on these slates is traceable close to the serpentine mass; where they have lost their dark colour have become of a yellowish olive colour, very soapy in feel, and gradually pass into the ordinary blackish slates of the neighbourhood.

In classing these rocks with serpentine, the author stated that it frequently became necessary, viewing rocks geologically, to class under such divisions, masses which, in much of the area over which they extend, may not present those definite mineral characters which would justify a mineralogist to name them similarly in his cabinet. Of this the present was an example; for much of this rock, though not such in aspect as would be placed in a mineralogical cabinet as serpentine, is still classed as such geologically, because it occurs with other portions which are so, and appears to have a common origin, similar relations with the adjoining rocks, and a slightly modified but not essentially distinct composition.

Much of the rock was stated to be very similar in aspect to the Anglesey Serpentine, and thus to form another link of connexion between the two districts, in other respects also so allied.

December 9th—"Notice of a peculiar Tufa from a bog in the County of Tipperary," by George J. Allman, M.D. Professor of Botany in the University of Dublin.

The subject of the present notice was discovered by Dr. Allman, in a bog about a mile to the west of Roscrea. It consists of detached lenticular bodies, varying from half an inch to an inch in diameter, and scattered over a considerable area of the bog, like a thin drift of gravel. This character, which may lead a hasty observer to mistake the phenomenon in question for a genuine drift of gravel, is evidently of some importance in a geological point of view. It requires, however, no very laborious examination to convince us of the true nature of the deposit, and a simple inspection of the component bodies will reveal facts inconsistent with the supposition of their being rolled fragments. When decalcified by the action of dilute acid they are found to possess an organic basis which would seem referable to *scytonema*, a genus of fresh-water algæ.

The deposit of calcareous matter in fresh-water algæ is by no means unprecedented. In certain Rivulariæ, for instance, we know that it occurs to a remarkable extent, and often when the water exhibits no tendency to deposit carbonate of lime upon surrounding

lifeless matter. Such facts would seem to point to laws beyond those of purely chemical action; and Dr. Allman was of opinion that the phenomena of calcareous deposition may be conveniently classed under *three* heads.

Under the *first* head we have a series of phenomena purely *chemical*. These occur where the carbonate of lime, held in solution by an excess of carbonic acid, becomes separated by the abstraction, under purely *physical* agency, of the superabundant acid. The simple exposure of the carbonated water to the atmosphere is the most common condition under which this result is brought about, and it manifests itself in the deposits of carbonate of lime upon surrounding objects almost indiscriminately. In this way are formed the calcareous incrustations for which certain springs have become so celebrated, as well as all ordinary tufas, and the various stalactitic formations. To this head may also be referred the genuine calcareous petrifactions, which would seem to differ from incrustations solely in the greater slowness of the process, and the fact that each particle of the original organic body is removed as a particle of mineral is added, the latter then taking the place of the original organic particle.

Under the *second* head may be classed phenomena which depart, to a certain extent, from the dominion of purely physical laws. They may be appropriately termed *chemico-vital*, and present themselves in the deposition of carbonate of lime upon the surface of *living* vegetables, to the comparative or absolute exemption of surrounding lifeless matter. They may be explained, Dr. A. thinks, by reference to the power—so eminently characteristic of vegetable life—of decomposing carbonic acid; the excess of acid being by this means got rid of, and the carbonate of lime deposited in an insoluble state. To this class may be referred the calcareous incrustations to which the Rivulariæ, Characeæ, and other water plants are peculiarly subject, as well as the instance which has given rise to the present communication. It would here seem necessary to suppose that the decomposing power is exercised more actively by some plants than by others, in order to account for the unequal deposit of the calcareous matter on the various species of plants growing in the same water.

The *third* class embraces those phenomena which are of a character purely *vital*. It is composed of the various instances in which carbonate of lime is deposited in the living tissues, by an act of genuine secretion, as in the calcareous coverings of the crustacea, and of the testaceous mollusca, the skeletons of the echinodermata, corals, &c. among animals, and the nullipores among vegetables. It differs from the last class chiefly in our being unable to call in the aid of chemistry to account directly for the phenomena; but perhaps after all this should be viewed rather as the resource of our ignorance than as possessing any real foundation in nature. The

progress of discovery is every day bringing under the dominion of physical laws, phenomena which till lately were believed to have been far beyond their influence, and to have had their causes for ever hidden among the recondite operations of the vital forces.

"On the geological structure of Glenmalur, in the County of Wicklow," by Thomas Oldham, A.M. Professor of Geology in the University of Dublin, &c. &c.

The author described in detail the very complicated relations of the granite and slate rocks in this district, illustrating his account by the detailed plans, prepared for the Geological Survey of Ireland by Warrington W. Smyth, Esq. Mining Geologist to the Geological Survey of the United Kingdom.

January 13th, 1847.—"Analyses of Auriferous and Argentiferous Coppers from South America," by Robert Mallet, Esq. Ph. D. M.R.I.A. &c. &c. President of the Society.

I beg to present to the Geological Society two specimens of South American Copper, containing the precious metals in large proportion. The specimens presented are parts of a cargo of copper, samples of which I was requested to analyze for an eminent mercantile house in England; I am therefore enabled to deposit also with the Society an accurate account of the constitution of these alloys of copper, which are not devoid of interest.

Many members are probably aware that there exist in South America many ores of copper possessing an extremely complex or mixed chemical constitution, and containing, in addition to several of the baser metals, a larger or smaller proportion of gold and silver. Formerly these were always treated, at the mine or near it, by the usual methods of the country for separation of the precious metals; and when the proportion of these fell below a certain standard, so that they would not pay for extraction in this way, the ore was neglected; or, if made into copper, was of small value, as this metal could not be made for all purposes workable on the spot. At a comparatively recent period, however, the mode of proceeding has been wholly changed, through the enterprise of our own metallurgists and refiners, and these coppers, comparatively poor in the precious metals, have now become valuable. The ores are smelted, and partially refined on the spot (with charcoal or wood fuel,) from some of the baser or alloying metals, as iron, &c. and in this state, combined with the precious metals, are shipped for England, where they pass into the hands principally of London refiners, who separate the gold and silver, and dispose of the copper, either in the

state of salts of copper, or as metal of the purest and finest quality.

The previously known methods of refining these metals, as well as of obtaining the noble metals from their ores directly, when so rich as to warrant their being treated in these kingdoms, have received a most important addition and improvement, by the processes patented in 1845, by Mr. John Taylor of London. His method briefly consists either in obtaining the silver in solution as chloride or as sulphate. The ore, if a compound sulphuret, or the metals, if in the reguline state, mixed with some sulphuret, such as iron or copper pyrites, are calcined until the sulphurets are converted into sulphates, and thence by continuing the operation into oxides, say of copper, iron, and silver, the gold if present remaining as metal. At this stage common salt is thrown into the furnace, and raked up with the oxidized metals, at a white heat. Chloride of silver is instantly formed; and the mass, when raked out and cool, is treated with a saturated solution of common salt, which dissolves out the chloride of silver, and which is then precipitated in the metallic state by metallic copper. The gold may be separated by washing and solution, by any of the known methods.

By a variation of the process, Mr. Taylor stops the calcination at the point when all the sulphurets have been converted into sulphates. The silver is now in the state of a soluble sulphate, and may be washed out with hot water, and precipitated by any known method.

This beautiful process removes the great previous difficulty in the treatment of these alloys or ores, namely, the necessity of dissolving the whole mass in menstrua, to obtain the precious metals, and seems likely to be to the refining of argentiferous coppers, what Patterson's process is to the extraction of silver from lead.

As the methods of analysis pursued by me were those usually adopted, it does not seem necessary to detail their steps. As, however, extreme accuracy, in determining the amount of the precious metals, was here indispensable, to fix the market value of so large a mass of valuable material, the following results are had from the mean of three analyses each, which accounts for the occurrence of four places of decimals, being one beyond the reach of the balance.

I may observe here, that of the two methods usually followed for the analysis of insoluble compounds of gold and silver, neither gives absolutely correct results. If the mass be dissolved in nitric acid, the gold alone remains as neutral; but although this be so finely divided as to have scarcely any metallic lustre, its particles still involve and screen from solution a trace of silver. If, on the contrary, the mass be dissolved in Aqua Regia, the silver remains as chloride, but involving a sensible quantity of gold, whatever be the care with which the solution is made.

As the gold is the more precious metal, and present in the smaller proportion, I have always preferred the former mode of proceeding;

and by boiling the metallic gold for a few seconds in Caustic Ammonia, and testing for silver, almost complete accuracy may be ensured.

The following are the constitutions of the specimens of copper now presented:—

Square Ingot, No. 1.

Copper, ...	97.9120
Silver, ...	1.9730
Gold, ...	0.0527
Tin, Lead, Iron, Sulphur, }	traces.
	99.9377

Round Ingot, No. 2.

Copper, ...	96.3960
Silver, ...	3.4170
Gold, ...	0.0533
Lead, ...	0.0660
Tin, Iron, Sulphur, }	traces.
	99.9323·

The latter gives a doubtful trace either of Antimony or Bismuth. None of the metals mentioned as *traces*, are present in sufficient quantity to admit of being weighed.

These valuable alloys therefore contain from 19 to 20 ounces of gold, and from 700 to 1200 ounces of silver to the ton of metal, and thus are worth about £400. per ton.

" Results of Analyses of Serpentine, from the County of Galway," by Matthew D'Arcy, Esq. Member of the Society.

The specimens subjected to analysis were part of a large and fine specimen of Galway Serpentine, obtained some time since from George Wilkinson, Esq. by Professor Oldham, by whom a portion was given to Mr. D'Arcy for analysis. The rock within was of the ordinarily bright green colour of the serpentine from that County, but externally it was much altered in appearance, had quite lost the rich colour, was of a dirty greenish white, somewhat powdery and flaky in aspect. A portion of both the decomposed and the fresh parts was submitted to examination, and the results were as follows:—

	Decomposed. Sp. gr. 2.2223	Undecomposed. Sp. gr. 2.6460
$Si\,O_3$	48.833	46.128
$Fe_2\,O_3$	6.375	4.512
$Ca\,O$	1.860	5.245
$Mg\,O$	29.459	27.671
$Al_2\,O_3$	3.800	3.185
HO	8.760	12.498
Loss	.913	.761
	100.000	100,000

JOURNAL

OF THE

GEOLOGICAL SOCIETY OF DUBLIN.

VOL. III. PART IV. 1847. No. 1.

AT THE

ANNUAL GENERAL MEETING,

HELD ON

WEDNESDAY, FEBRUARY 10TH, 1847,

ROBERT MALLET, ESQ. PRESIDENT, IN THE CHAIR.

The following Report from the Council was read:—

"Your Council have not to direct the attention of the members to any very marked feature in the progress of the Society during the past year. The meetings have been well attended, and papers of considerable interest have been brought before the Society, as will appear by the President's address.

"Your Council have to report the completion, in duplicate, of the Ordnance Survey Maps of Ireland, presented to your Society by his Excellency the Lord Lieutenant; and they think it well to observe that this donation is rendered particularly valuable by the possession of the duplicate maps, which afford very great facilities for the practical exertions of your members.

"Your Council would also direct attention to the extensive collection of charts presented by the Lords of the Admiralty, as a highly valuable contribution, affording data for the consideration of many important geological questions. These donations, together with that of the excellent maps and sections of the Geological Survey of Great Britain, are an evidence of the importance attached to your pursuits by the government of this country, and should be an encouragement to further exertions on the part of the members.

"During the past year the following members have been added to the Society:—

Thomas Hamilton, Esq.	M. D'Arcy, Esq.
Sir James Murray, M.D.	Bernard B. Murray, Esq. C.E.
Sir John M'Neill, L.L.D.	Walter S. Willson, Esq.
P. Waddy, Esq. M.D.	

"Your Treasurer's accounts are submitted herewith, and by the abstract it will appear that the financial condition of the Society has much improved, as compared with the close of last year.

"Your rooms have continued to be occupied by the Institution of Civil Engineers for the purposes of their meetings, andy our Council have endeavoured to afford to the institution every accommodation in their power.

"Your Council, by the appointment of Mr. Du Bourdieu, as Curator of the Museum and Assistant Secretary, have effected a considerable diminution of the annual expenditure, and in closing their report, they feel great pleasure in stating that his attention to the duties of his office has afforded to them complete satisfaction."

Abstract of Accounts of the Geological Society, for the year ending February, 1847.

Cr.	£.	s.	d.
By Life Subscriptions,	30	0	0
— Admission Fees,	7	0	0
— Annual Subscriptions and Arrears,	92	0	0
— Payments of Institution of Civil Engineers towards expenses of lighting, &c.	5	8	0
	£134	8	0

Dr.				£.	s.	d.
To Balance due to Treasurer as per last Account,				7	0	7½
— Assistant Secretary's salary from 1st January to 1st July,				30	0	0
Do. do. from 1st July to 31st December,				15	0	0
— Carpenter's work: large case for maps,	7	0	0			
— Painting, &c.	0	10	0			
				7	10	0
— Printing Journals, Stationery, &c.				17	15	1
— Incidentals, including Postage, Carriage of Parcels, expenses of Meetings, Porter, &c.				17	15	1
— Coals,				1	16	0
— Engraving maps, &c.				2	10	0
— Balance in Treasurer's hands,				35	1	2½
				£134	8	0

I have examined the above account, and compared Vouchers, and find it correct.

10th February, 1847.

ROBERT CALLWELL.

List of Donations received since the last Anniversary.

TO THE MUSEUM.

1846.

Mar. 11.—A Series of Fossil and rock specimens, being the completion of a large series formerly sent, from the Right Hon. the Earl of Enniskillen.

—— 14.—A Specimen of Spirifer princeps, (M'Coy) from the County Kildare, from C. Farran, Esq. M.D.

Apr. 1.—Two fine specimens of Filamentous Carbon, obtained coking ovens, from the coal of Bransby, from R. Mallet, Esq. President.

May 7.—Some (Carboniferous) Limestone Fossils from Bunown, near Ballymahon, from Ross Mahon, Esq.

—— 20.—Two Specimens of Ammonites from Oxford clay, from W. Andrews, Esq.

June 1.—Specimen of Calp, which separates spontaneously into fragments on exposure to air, from County Dublin, from R. Mallet, Esq. President.

Two Specimens of Green Steatite, from the Luganure Mines, County Wicklow, from R. Mallet, Esq. President.

Oct. 26.—A Specimen of Trap, from Sugar loaf Hill, County Waterford, from R. Mallet, Esq. President.

1847.

Jan. 13.—Fine Specimen of Saurian Bones, from the neighbourhood of Whitby, (set in mahogany case) from R. Mallet, Esq. President.

Two Specimens of Copper ore containing a large amount of precious metals, from South America, from R. Mallet, Esq. President.

TO THE LIBRARY.

1846.

Mar. 11.—Charts of Ireland and of the west coast of England, from the Lords of the Admiralty, through Captain Beaufort.

Mar. 14.—Annual Report of the Leeds Philosophical Society, for the years 1844—5, from the Society.

1846.

Mar. 23.— Sections published by the Geological Survey of Great Britain, and the index of colors, in all 32 sheets, from The Chief Commissioner of Woods and Land revenues, through Sir H. T. De La Beche.

Apr. 1.—Third bulletin of the proceedings of the National Institute for the promotion of Science, Washington, from the Institute.

——27.—Sheet 9 of vertical sections, from the Chief Commissioner of Woods, Works, and Land revenues.

May 7.—Charts of the coasts of France, Spain, Portugal, and the Baltic, from the Lords of the Admiralty, through Captain Beaufort.

Aug. 3.—Observations on the Geology of the Egyptian Desert, with Plates of Egyptian Fossils, by A. B. Orlebar, M.A., from the Author.

Oct. 1.—Address delivered at a Meeting of the British Association for the advancement of science, by Sir R. I. Murchison, Southampton, Dec. 10th, 1846, from the Author.

—— 24.—Memoirs of the Geological Survey of Great Britain, and of the Museum of economic Geology of London, Vol 1., from the Chief Commissioner of Woods, &c. &c. through Sir H. T. De La Beche.

—— 26.—Two complete sets of the Ordnance Survey Maps of the Co. Kerry, from His Excellency the Lord Lieutenant, through Colonel Colby, R.E.

Dec. 2.—Reports of the proceedings of the Geological and Polytechnical Society of the West Riding of Yorkshire, comprised in 11 Pamphlets, from the Society.

—— 2.—Report of the British Association for the advancement of science for 1845, from the Association.

—— 18.—A Pamphlet on the Superficial Detritus of Sweden, &c. &c. by Sir R. I. Murchison, from the Author.

The Mining Journal for 1846.

Resolved.—That the Reports now read be confirmed, and such parts of them, together with the Treasurer's accounts, as the Council may think fit, be printed, and circulated among the Members.

A ballot then took place, when the following gentlemen were elected Officers of the Society for the ensuing year:—

President.

ROBERT MALLET, ESQ.

Vice-Presidents.

RICHARD GRIFFITH, ESQ.
JAMES APJOHN, ESQ. M.D.
SIR H. DE LA BECHE,
THE RT. HON. THE LORD CHANCELLOR,
THE EARL OF ENNISKILLEN.

Treasurers.

WILLIAM EDINGTON, ESQ.
WILLIAM MURRAY, ESQ.

Secretaries.

ROBERT BALL, ESQ.
PROFESSOR OLDHAM.

Council.

JOHN SCOULER, ESQ. M.D.
C. W. HAMILTON, ESQ.
JOHN MACDONNELL, ESQ. M.D.
THOMAS HUTTON, ESQ.
REV. H. LLOYD, D.D.
GEORGE WILKINSON, ESQ.
ROBERT CALLWELL, ESQ.
WILLIAM ANDREWS, ESQ.
W. T. MULVANY, ESQ.
SIR ROBERT KANE, M.D.
PROFESSOR ALLMAN,
GEORGE V. DU NOYER, ESQ.
MATTHEW D'ARCY, ESQ.
CAPTAIN LARCOM, R.E.
M. B. MULLINS, ESQ.

The President then read the ANNUAL ADDRESS. After the address had been concluded, the following Resolutions were unanimously passed: —

"That the cordial thanks of the Society be presented to the President, for his constant exertion in the cause of the Society during the past year."

"That the warmest thanks of the Society be presented to the several Officers of the Society, for their zealous attention and endeavours to promote the objects of the Society during the past year."

The Society then adjourned.

ADDRESS.

GENTLEMEN,

Upon this the sixteenth anniversary meeting of the Geological Society of Dublin it is my duty, as President, to pass briefly in review our proceedings during the past year—the communications which we have received—the additions which we have been enabled to make to the common stock of knowledge in the science, for the cultivation of which our Society is established—and surveying with an expanded glance the progress of research, and the acquisitions already made by ourselves, and our fellow labourers in other places, to indicate the directions in which our future exertions, whether individual or combined, may be devoted with the greatest advantage to geology.

The year that is passed has been marked to our country as one of calamity and gloom. The food which hitherto formed the staff of life to millions of our fellow-countrymen, has suddenly perished here and elsewhere, in a manner, the comprehension of which has bid defiance to the researches of science. In passing, we might draw a plea from this unlooked-for and fatal event in favour of those abstract investigations of nature, in all her domains, which we are engaged in systematically pursuing in one. To the mere utilitarian, the failure of science hitherto to throw light upon the potato rot, seems an accusation against science itself; but even to the utilitarian, if better informed, it should prove that new phenomena and new difficulties, presented to man's energies by nature, cannot be overcome or even understood in the moment of emergency, but in so far as the knowledge and power of general laws, previously known, can be brought to bear upon them—laws to be sought out through much time and labour in every department of nature, by researches such as we are engaged in, and which, when obtained in quiet and leisure, become the armoury, whence we draw weapons to combat and subdue the physical troubles into which it is man's estate to be born.

The past year has thus been rather a time for our exertions as citizens, than for our research as philosophers, for the exercise of social virtues rather than for intellectual progress; so that many of our most valued members have been prevented by the pressure of duties abroad from their usual attendance at our meetings, and contributions to our transactions. The mind, however elastic beneath the pressure of its proper labour, is ill befitted for intel-

lectual exertion when the spirit is depressed by care, either for ourselves or others—Cum vacui curis, etiam quid in cœlo fiat, scire avemus.

Notwithstanding these untoward conditions, however, I am enabled to congratulate the Society upon the character of the communications it has received during the past year, and upon the undiminished interest with which its meetings are attended.

The Society has had presented to it, and read, fourteen communications during the year. The first of these, in the order in which they were respectively read, was one by myself, "On some secular and diurnal motions of the earth's crust." In this paper I have endeavoured to draw the attention of geologists generally, to the importance of making observations of measure, number, and weight, on geological phenomena, in addition to those merely of kind or quality, with which geologists have hitherto chiefly contented themselves. I urge the necessity of such as bases for every advance towards a sound system of geological dynamics; and I point out two promising and important directions, in which such observations of measure may be with advantage immediately applied—namely, to the direction, velocity, and extent, of undulation of earthquake shocks, and to the conditions and extent of certain small secular and diurnal motions of the earth's crust, hitherto remarked only by astronomers, and presumed to arise from changes of temperature.

With regard to the former class of motions, I have briefly referred to my own views of earthquake dynamics, now published in the last volume of Transactions of the Royal Irish Academy, and endeavoured to show the extent of knowledge, that we may expect to accrue to geology, from the prosecution of a system of observations and measurements of earthquake shocks. I showed that this system, must be co-operative to be effectual; and I proposed, with the permission and aid of our council, to bring the subject before the British Association, and to seek its aid in carrying out the objects in view in such way as might be considered most advisable.

This has since been done, and I have the pleasure of informing the Society, that some progress has been made in commencing a train of physical research upon earthquake dynamics, which, originating in our Society, must, I am confident, hereafter yield a rich harvest of geological truth, and mark an epoch in its advancement. At the late meeting at Southampton, propositions were laid before the governing body of the British Association, proposing certain experimental investigations relative to the transit of waves of elastic compression, or earthquake shocks, through the earth's crust, and also requesting reports to be drawn up upon the state of our knowledge of the subject. The Association was prevented by circumstances from adopting the experimental portion of the inquiry at present; but responding to our views with readiness

and zeal, as far as possible, it has directed the preparation of two preliminary reports upon earthquake phenomena, and upon the application of the theory of vibrations to these, which, it is hoped, will form a suitable prelude to further investigations, and to future combined experimental researches.

Our respected member also, the President of the Royal Irish Academy, has alluded, in his inaugural address to that body, to the value and importance of this line of research; and has taken measures for the systematic record in the magnetic observatory of the University of Dublin, of those minute, but frequent, shocks of earthquakes, which, although not perceptible to the unaided senses, are detected by the refined instruments there in use, and by means of which their existence was noticed at an early period, by Professor Lloyd here, and previously by Arago and Biot in France.

The systematic observation and admeasurement of the small secular, or periodic motions of the earth's crust due to temperature, will, we may hope, hereafter meet due attention from astronomers. These motions have been first remarked at the Observatories of Armagh, Dublin, and Markree, as mentioned by Sir William R. Hamilton, Astronomer Royal, in the communication to me, which I had the honor of reading to you as part of my paper.

On the geological bearings of these latter observations, I would only here repeat, that it is a region of investigation hitherto utterly unknown, and by penetrating which, it will probably be found in this, as in so many other parts of terrestrial physics, that forces and motions the most minute and scarcely to be detected, are, when taken in aggregate, essential and potent parts of the universal machine.

The next paper brought before us, was a brief description of the coast in the vicinity of Kilkee, County of Clare, by Mr. Du Noyer, accompanied by drawings in that vigorous and striking style which he has made his own, and which is so peculiarly fitted for geological illustration.

The author described several of the scenes presented in his drawings, which showed the general rocky structure, and character of degradation of the coast and adjacent islands, by the action of the waves. Observations of this class, made with a philosophic eye, and well recorded and depicted, are of great value, and nowhere in Europe can the effects of the sea upon the land be more variously and strikingly found than along the line of our Atlantic shores, where

"Breaks the long wave that at the Pole began."

At the extreme north we may study its effects upon unstratified primary rocks exposed in every position,—further south, as at Bundoran and the Sligo coast, we may remark the peculiar modes of destruction of the vast horizontal tables of limestone projecting

into the deep; again southwards, we find it wearing away the flinty sienite of Galway, and towards the southern extremities of our island we may investigate the beds of slate, exposed to the fury of the waves in every position, from the vertical to the horizontal. We may find in the deep bays and inlets, and amongst the innumerable islands, the effects of marine currents and confined tides, acting in concert with the ceaseless stroke of the billow; and upon some parts of the low-lying shores we may remark the winds, in concert with vegetable life, acting as geological agents, in piling up again the vast dunes of sand already supplied by the sea from the abraded and pulverized rocks.

The extension of observations upon our western coast is much to be desired, and if made with constant regard to dynamic and hydrodynamic laws, will not fail of throwing much additional light upon the generally received doctrines of transported materials.

Mr. Du Noyer mentions the Island of Illaun-Asp-Magurtha, upon which there are the remains of a stone-roofed chapel, and of some circular stone-roofed or beehive houses, which he considers were erected probably in the fifth or sixth century. He states that the island must have been materially altered in form and outline since the erection of these buildings, and attributes these changes partly to great landslips caused by the shaly character of the rock.

In this the author glances at a subject which has always appeared to me of high interest, namely—the meeting point of palætiological science with archæological lore, that in which the antiquary and the geologist may give and receive assistance from the joint pursuit of their respective studies. It is a subject as yet scarcely touched by British research, although not neglected by foreign geologists. I may instance the important papers of Professor Forchammer, of Copenhagen, upon the peat bogs and drift of Denmark. Ireland, and especially its coasts, abound with cases analogous to that cited by Mr. Du Noyer—as in the Isles of Arran on the west, and on the coasts of Dublin and Louth upon the east, where we find buildings once inland now standing on the edges of cliffs, and partially destroyed by the inroads of the sea upon the land. Time, however, forbids my descanting upon this inviting topic, in which even philology may occasionally lend some aid to geology; as, for example, in indicating the probability that when the now single rock was named "The Mumbles," more than one stood above the sea.

Our next paper was by Professor Oldham, upon *Griffithides globiceps*, and some other carboniferous fossils.

The object of the first part of this paper is to reconsider the conditions upon which certain mountain limestone trilobites, referred to the genus Asaphus by Phillips, and previously, it appears, by Fischer and other continental authors, were subsequently disposed of by Portlock in two new genera, established by him for their reception, viz.—Griffithides and Phillipsia, of the former of which

Griffithides globiceps may be considered as the type. The author proceeds to show that doubt and discrepancy exist in the descriptions of various authors, as to the latter species, and judiciously remarks, that when such is the case, whether arising from previous authors having imperfectly described, or described from imperfect specimens, or described without figuring, the best method is to redescribe and figure from time to time the species in dispute from the most perfect specimens that present themselves. This Mr. Oldham has done, and as the result of a careful discussion of the whole subject, is disposed to agree with De Kōninck, in thinking that there is no sufficient ground for retaining the two genera Griffithides and Phillipsia, and in referring all those trilobites to the genus Phillipsia of Portlock.

A part of the doubt heretofore existing as to those genera, has lain in the uncertain descriptions given by authors of the eyes, by some described as smooth, by others as reticulated. Instances are frequent, in which a false or dubious reticulation of the softer animal tissues has been produced in the process of fossilization; and I would suggest to our palæontological members, that the examination by the microscope of thin slices from such tissues, would probably not only settle the question as to the composite structure of the eye, but be of great interest, as throwing fresh light upon the conformation of the visual organs in these singular and ancient animals.

The next portion of Mr. Oldham's paper relates to a fossil described as crustacean, by Mr. M'Coy, and named by him Astacus Phillipsii. This the author considers, after mature examination, to be not a crustacean, but a part of the hinge portion of a brachiopode shell seen from within. Mr. M'Coy's view has been supported by the authority of Agassiz; but Mr. Oldham states that that naturalist's examination was cursory, and made several years since.

The next portion of Professor Oldham's paper points out for the first time the existence of certain organs of attachment in the genera Gorgonia, Retepora, Fenestella and Phylopora. These genera have been long favourites with palæontologists from their beauty; and many species have been described under each, but, as in the preceding case of Phillipsia, often from fragmentary specimens incapable of giving the whole and true character of the species; there seems little doubt that many of these species must be hereafter abolished.

The author shows that former describers, while they have noticed the long solid nonporiferous root at the base of these corals, have overlooked the lateral processes which he has been the first to notice, and of which he has given some good figures. These grow ometimes at the distance of nearly a foot from the root, and extend for several inches, and are considered by the author as thrown out by the coral animals as cables by which they might secure their delicate edifices from the dash and commotion of the waves.

The author also shows that the distinction between Ptylopora and Fenestella, grounded upon the existence of a mid rib, is insufficient, and he thinks it probable that both may be referred to Gorgonia.

The last part of Mr. Oldham's paper also treats of an instance of description of organic remains from incomplete specimens. A shell, which Mr. Oldham considers as Avicula orbicularis, was described by Mr. M'Coy as a Malleus. From the supposed longitudinal striation of the opposite valve to that figured by the latter—from the inequality of the valves—and lastly, from the improbability of shells found in the Palæozoic rocks being referable to genera, confined, as far as our knowledge goes, to the more recent deposits—the author, is induced to retain this shell as an Avicula until, at least, the examination of both valves of perfect specimens can be had.

The precise distinguishment of fossil genera and species, at which Mr. Oldham has thus laboured, is not a matter of mere conventionality or taste to the natural historian, but one of the first importance to the geologist. Palæontology, besides its own special and inherent claims as one of the noblest fields of natural history, and the one of which natural historians are justly proud, as that of some of their greatest intellectual triumphs, demands the regard of the geologist as one of the most certain and universal instruments of descriptive geology. Palæozoic genera and species are the alphabet by which we spell out the shattered inscriptions, recording the events of ages long past before our race was created; it is, therefore, of the last importance to the certain deciphering of these that we should be indubitably clear as to the value and import of the letters we apply.

At our meeting of the 8th April, Professor Scouler presented to us the first fruits of his sojourn in Portugal, in a paper on the geology of the neighbourhood of Lisbon; he described the general structure of the district as far as Cintra, and presented to our notice a collection of highly interesting fossils—Hippurites and Birostrites, which he considers as belonging to the class of the Balani. These fossils are from the chalk limestone, and are peculiar to this formation in the south of Europe.

The author stated his reasons for considering the bluffs in which these fossils are found as ancient sea cliffs, left by denudation, and giving proofs of elevation subsequent to the tertiary period.

This paper has not yet been printed in our proceedings, the completion of the subject awaiting the author's then projected revisit to Portugal. Doctor Scouler has, since the period of this communication, again safely returned from his study of Portuguese geology; and we expect with interest the share which our Society looks for at his hands of the information which he has obtained.

On the 13th of May, we had a notice from Captain James, Royal Engineers, of the tertiary deposits of the county of Wexford. The area occupied by these deposits extends from near Arklow, as far south as Kilmore, and inland to Gorey, Ferns, and Enniscorthy, or

about forty miles in length by eight in width. The greatest altitude at which these deposits, consisting principally of sand and gravel, covering dark tenacious clays, very like the London clay, are found, is 400 feet. They reach in depth at least 174 feet, and almost invariably repose upon a bed of rolled and water-worn pebbles, which Captain James views as of the age of the so-called Northern Drift. In the Barony of Forth, these clays are of an average depth of seventy feet, and were obviously deposited in a tranquil sea, as evidenced by the rows of imbedded Nullipora, and the perfect preservation of the delicate and fragile shells of the Fusus bamfius.

Captain James is of opinion that those tertiaries are the remains of a far larger deposit, which have been preserved, by the shelter of the mountainous regions to the north, from the denuding effects of the great current which he considered brought down the Northern Drift, and extended over all Ireland; and he instances a block of coal discovered in the clay in the county Wexford, at an altitude of 230 feet, which Mr. Griffith considers as wood coal from Antrim.

While I fully agree with Captain James in his view, that these marine deposits were precipitated in a tranquil sea, the tranquility of which was due to the high lands then above the sea level to the north and west, I can by no means subscribe to the prevalent doctrine of some one or more cataclysmal deluges having swept over the whole of the then submerged surface of Ireland, and convulsively carried along the so called Northern Drift. On the contrary, I am impressed with the conviction, that the deposition of these tertiaries was due to the long continued and comparatively quiet action of the tides and marine currents of the ancient ocean, acting upon the detritus of still more ancient lands, combined with the then active motions of elevation by which our Island has been raised to its position above the sea level. I would further venture to express my belief, that future and not distant researches will show that the ordinary motions of the sea in connection with forces producing elevations of the land, both acting upon the loose materials of which the sea bottom principally consists, and producing therein great and varied movements laterally by sorting and direct transport, and also by the slipping or movement *en masse* of the beds of loose materials, as mud, gravel, &c. on the inclined beds of rock supporting them, constitute a sufficient machinery to account for all the cases of transport hitherto observed.

Captain James's paper gives us a list of seventy-four fossils from these deposits named by Professor E. Forbes, only twenty-six of which had been previously described from this part of Ireland.

At the next meeting, June 10th, I commenced the reading of a paper upon the formation of the fissures of mineral veins and dykes, which I regret to say, other duties have as yet prevented my completing, but which I hope to be enabled, with the permission of council, to bring again before the Society this year. The view

which I advocate in this paper is, that the circumstances of fracture of mineral vein fissures, indicate that they have not usually resulted from a mere tearing asunder of the rocks in which they occur by tensile strains, produced by forces of elevation, (in which case, in place of being generally remarkable for the regular rectilinearity of their courses, they would be as remarkable for their jagged irregularity, in following the lines of least resistance of the masses broken;) but that they are sudden fractures, due to the transit of waves of elastic compression through materials of variable elastic moduli—lines in fact of broken unison. Such forces may have been, and probably were accompanied by strains produced by the ordinarily recognised forces of elevation.

On the same evening Professor Oldham gave us a paper upon the supposed existence of moraines, in Glenmalur, county Wicklow.

The valley of Glenmalur runs from N.W. to S.E. for about six miles in length, with but one important lateral valley, at the junction of which the large gravel heaps are observable, which have been mistaken for moraines. This lateral valley is a site where certainly the existence of a glacier, reposing upon the great flank of Lugnaquilla, is a possibility; but a careful examination of this valley shows no collateral evidences of glacier action; and Mr. Oldham shows that the smoothed surfaces of rock at the head of the valley, and the existence of isolated granite boulders in its hollow may be accounted for by operations of daily occurrence. The gravel banks themselves, when viewed with a superficial glance, do present much of the external character of moraines; but Mr. Oldham produces a conclusive argument as to their true nature, in showing that they are irregularly stratified, and present all the character internally of our common gravel hills, which are admittedly aqueous deposits.

He considers these assumed moraines to have been valley bars, originally formed when the valleys were still submerged—that a lake existed posteriorly in the lateral valley, the overflow from which passed across the bar of loose materials, and fell over a steep declivity into the main valley. In the ordinary progress of erosion the bar was worn away, and probably in periods of great floods the channels of overflow frequently changed their positions, the dry beds of ancient channels being even now visible; at length the lake was wholly drained, the lateral valley became dry, as we now find it, with a stream winding along the bottom, and the ruin of the former bar, or bars, remains accumulated in the heaps we now behold.

Similar causes produced the smaller gravel heaps in the upper part of the lateral valey, as well as some others, which Mr. Oldham has described lower down the main valley of Glenmalur.

A good deal of general interest and of geological value attaches to this case, which professor Oldham has so ably elucidated. When the attention of British geologists generally was first attracted to the

subject of glacier action, (which I believe I am safe in stating, had received no recent attention whatever in these countries until the period of my own notice of the subject at the Liverpool meeting of the British Association, now ten years ago,) it was painful to every mind anxious to pursue truth, to observe the indiscriminate eagerness with which moraines, so called, were discovered and described in places and under circumstances which precluded the possibility of the existence of glaciers; this preliminary inquiry—can a glacier have here existed under any conceivable modification of climate—seems seldom to have been made. The case before us, however, is one in which this inquiry must have been answered in the affirmative; and wherever this is so, the greatest caution, the most careful examination not only in detail, but still more by bird's eye view, is necessary to enable the geologist, however thoroughly imbued with the knowledge of aqueous and glacial forces to arrive at a certain and just conclusion.

There are few, if any, phenomena producible by the action of glaciers in motion that are not also producible by aqueous forces acting on mixed masses of detritus of every sort, from mud to boulders, when combined with the slippage of the masses themselves upon their sustaining beds—even to the furrowing, rounding, and scratching of the rocks beneath. To decide to which class of actions a given case belongs, therefore requires a broad and comprehensive glance, in which the instructed eye and reason, commanding the resources of the mechanics of solids and fluids, shall work in concert with and still control the imagination, that noble faculty by which alone we seize such geological problems as a whole.

Our third paper for this same evening was by Mr. James M'Adam, of Belfast, on the appearances brought to light by the tunnelling operations at Down Hill, county of Derry.

The author describes the character of the trap rocks exposed to view in two tunnels, one of 700 and the other of 300 yards in length, upon the line of the Derry and Coleraine Railway, which he states confirm the observation of Captain Portlock in his geological report of the district.

Some of the facts observed specially by the author, however, are interesting. He found at the eastern entrance of the longer tunnel that masses of hard trap were mixed and interlaced with soft in the most irregular manner. The soft trap is the more frequently amygdaloidal, and the hard is sometimes concretional in concentric shells. The surface of the trap had in some places a rubbly character; harder portions of various sizes being mixed with it—a structure, probably similar to that observed by myself some years since in the trap dyke of Galway, of which an account has been printed in the Transactions of the Royal Irish Academy. The trap rock here exposed abounds in minerals of the Zeolitic family—mesotype is however scarce—specimens of great beauty are found

of most of the species of which the author has given a catalogue; and the paper contains some remarks of much interest as to the diverse character of the minerals found in the trap rocks of the north of Ireland, in several different localities. This is a line of research as yet untrodden, and one the pursuit of which would probably be of importance, as giving some additional information both as to the geology and the chemistry of basaltic formations.

Complete catalogues of the basaltic imbedded minerals found at distant localities in Ireland, would be valuable, if forwarded, with suites of specimens to our Society, and from their abundance we may hope to have this accomplished through Mr. M'Adam or some other of our members. Time would not permit me to enter upon the inviting topic of the peculiar interest that attaches to the special minerals of the trap rocks; nor would it be necessary that I should urge this upon the attention of the Society.

Mr. M'Adam's paper concludes with an account of the interesting engineering operations successfully performed in the execution of these tunnels, of exploding by the battery two mines containing nearly 4,000lbs. of powder, under the effects of which the numerous joints and fissures of the trap rock were found to make it part with great ease.

On the 11th November, I presented to the Society some shells and fragments of shells, stated to have fallen during a violent thunder storm last summer, at Oak Park, county Carlow. That some solid substances of terrestrial origin, as fish, reptiles, fungi, seeds, &c., are occasionally carried up by meteoric forces, and precipitated in showers at a distance from the points whence they were snatched, is beyond dispute. Some other substances of a heavier or different character have been at various times described as being in like manner deposited, but with circumstances leading to doubt the accuracy of the narrative.

Shells have very rarely indeed been included amongst these strange visitants from the upper air. It came accidentally to my knowledge that such an event was said to have occurred in the county of Carlow, and I deemed it worth while to make inquiry as to the facts, and the reply I received is contained in the letter of the person who states that he gathered the shells which he forwarded to me, (and which are, with the accompanying letter, now in possession of the Society,) from a surface of closely shaven and swept grass directly after the storm; he had examined the locality shortly before, and he infers that those shells must have fallen during the storm; other persons witnessed their being spread over a considerable surface. The observer and describer was not aware previously to my writing to him that there was any particular interest attaching to the shells, and is not likely to have been guilty of any deception.

The direction of wind was from the south-east and by east, when the storm took place. The nearest point of the sea shore, therefore,

in the direction of the wind, would be about the sands of Wexford, and on examining the shells, all of which are small, they are found to consist of a few common land shells, mixed with a larger proportion of the most common littoral shells of our coasts.

A question was raised by Mr. M'Coy, whether one of the bivalve shells was not of an exotic species, which, had it been so, would have at once disentitled the whole affair to further scientific consideration; but a careful examination of the shell* in question, strengthened by the opinion of our valued member, Mr. Ball, has satisfied me that the whole of the shells are common native species. I am, therefore, disposed to view the history of these shells as worthy of preservation, in as much as every fresh instance collected with discretion upon a question of meteorology, doubtful and little understood, is of value—it is one more stone added to the foundation for a future edifice of truth.

It would be out of place here to enter upon any disquisition as to the probable conditions of transport of such bodies. The question has yet to be affirmed that they are transported. This is, however, just one of the points of natural history, in which, while we doubt, we should doubt with caution; in which the saying of the great English grammarian may be called to mind—that there is a vulgar incredulity as well as a credulous vulgar. I may also remind the Society that the reality of the fall of meteoric stones was scouted by the learned world little more than half a century ago; and although their existence, frequent traject and composition are now well ascertained, we are still absolutely in the dark as to their true origin and functions in the universe.

On this same evening Professor Oldham gave us an account of a small Boss of Serpentine, occurring near Roundwood, in the county of Wicklow, in the midst of the slate, and laid before us specimens of the rock.

The external character of Serpentine is in most of these not very well developed; in some specimens appearances would almost permit a casual observer to view them as altered mica slates, or protogenes, while others approach better to the character of the Anglesea serpentine.

In this case, as in that of many other highly composite and altered rocks, there is great difficulty in fixing upon a principle of nomenclature, where both the external characteristics and the chemical constitution of scarcely two hand specimens are found to agree. To cut this knot, it has been said by some, that nomenclature between the extreme limiting rocks, as, for instance, between certain slates and green stones, or slates and older sand stones, is a matter of "geological taste." This, however, is to destroy the

* A small and rather square specimen of *Donax trunculus*, supposed to be *D. denticulatus*.

whole use of nomenclature—to admit the difficulty, and lie helpless beneath it.

The ultimate appeal must, it appears to me, rest in chemical analysis, in cases where palæontology or circumstances of position can throw no certain light; but to make this available to the instances of rocks so variable in constitution as common serpentine, a convention must be established amongst geologists as to the limits of excursion from a given type, within or without which the rock being found shall decide its title. Thus the type of common serpentine would be the simplest formula of precious serpentine—$Mg.Si_3.+Mg.$ Aq., and no rock, whose average composition, deduced from the analysis of extreme and mean specimens, gave a per centage of the characteristic mineral, (in the present case magnesia,) less than the assigned limit below that of the type, should be viewed as belonging to its class.

By thus fixing upon the characteristic element of the rock, as that alone necessary to be determined, the tedious labour of complete analysis is reduced to the assay of one or at most two elements. But time forbids my pursuing this subject here.

In the preceding remarks I would not be understood as casting doubt on the correctness of classification made, in the present instance, by Professor Oldham, and Sir Henry De La Beche, which I am inclined to think analysis would fully sustain.

I cannot pass from this paper without observing, that this discovery of serpentine, though but a first fruit of the recently commenced geological survey of Ireland, well illustrates the necessity and the value, scientific and economical, of that important public work. We may anticipate that many another valuable mineral, many a spot prepared by nature for the seat of future busy industry, and the enlargement of national wealth and power, will be pointed out to the informed eye, that shall scan the minute and accurate maps, now in progress, of the geology of our country.

I must also congratulate the Society upon the hearty good will and zeal, with which the Director General has given the earliest intimation of some of these discoveries to this Society.

The eleventh paper was brought before the Society on December 9th, by Dr. Allman, containing a notice of a remarkable calcareous tufa, from a bog in the county of Tipperary. It consists of detached lenticular bodies of small size, covering as a thin layer a considerable surface of bog.

Dr. Allman decides that it is not a transported material, whatever casual resemblance it may bear to it.

By the action of dilute acids he found it possessed an organic structure or skeleton, and refers it to the genus Scytonema, a fresh water alga.

Dr. Allman then proceeds to discuss generally the conditions of deposit of calcareous matter upon or within organic or other bodies; he views these as threefold.

First—Waters holding carbonate of lime in solution, with excess of carbonic acid, may deposit the former on immersed objects, by agency purely chemical, as in the case of solfataras.

Secondly—The excess of carbonic acid may be abstracted by certain classes of aquatic plants, endowed with peculiar energy for its decomposition, as the rivulariæ, characeæ, &c., and the insoluble carbonate thus deposited upon them, under forces which the author designates as chemico-vital.

Thirdly—Carbonate of lime may be deposited by a true secretion in the living tissues, in a state of more or less complex combination, as in the cases of the crustaceous and testaceous molluscs. Here the forces are vital; but Dr. Allman well remarks, that perhaps all these will be hereafter brought under the sole dominion of chemistry, as the progress of discovery is every day reducing to physical laws phenomena which, till lately, were believed to have been far beyond their influence, and to have had their causes for ever hidden in the recondite operations of vitality.

Our next paper, on the same occasion, was by Professor Oldham, giving an account of the geological structure of Glenmalur, and illustrating it by the maps of the Geological Survey in Ireland, the second instance during the past year in which this Society has been the primary depository of the discoveries of the survey.

We learn from Mr. Oldham that we have in the district of Glenmalur one of the most striking and largely developed instances of granite intrusions in our islands, or perhaps in Europe.

A reference to the details of this paper is impossible without following the Geological Survey Maps. The granite is injected, dovetailed and embedded in the slates in the most extensive and remarkable manner, in long stripes, in large intruded masses, in thin veins running to mere threads, or sometimes expanded to a mile in breadth, and twisted and contorted in every direction, so that Mr. Oldham describes the rocks of the valley as a kind of gigantic breccia of granite and slate.

The author pointed out the rationale of this, namely, the forcible intrusion of the granite, and showed that much of the confusion now apparent arose from subsequent denudation and degradation. Proofs were adduced of the force and violence of the intrusion in the position of the slate beds, and the great development which they here present of contorted, reversed, fractured and rolled lamination.

Metamorphic action upon the slate is evident, though not so strongly marked here as in other parts of the district; and this Mr. Oldham justly and acutely attributes to the highly siliceous character of the slates, which may rather be considered as fine-grained grits, with thin argillaceous leaves interposed, than as presenting the common character of slates. The metamorphic action evidences itself by the slaty beds becoming micaceous, with garnets close to the junctions. Veins occur also in great numbers

in the granite itself, presenting their peculiar character of schorl being found towards their extremities, and along their walls. Professor Oldham concluded his paper, by considering the cause or mode of production of the valley of Glenmalur itself, whether by the throw of a fault or not. He showed the great difficulty of tracing this question in such a country, but conceived the evidence to be rather in favour of the former view. Thus the metallic lodes do not cross the glen, and faults do unquestionably exist at Ovoca valley which may be viewed as a continuation of this. The position of the lodes in both valleys was clearly shown upon the geological maps, the field work of which was due to the labours of W. Warrington Smith, Esq. mining geologist to the survey.

Professor Oldham also made some remarks upon the subject of the recent formations, occupying the bottom of this singular and beautiful valley; and added some new facts to those he had previously stated in June, respecting the gravel heaps, or bars occurring at the lower part of its length.

On the 13th of January of this year, in presenting two specimens of argentiferous and auriferous copper from South America, to the Economic Museum of the Society, I made some remarks upon the ores from which these were obtained, the methods of smelting, and the processes of refining now adopted, for the purposes of economically separating the precious metals from these cupreous alloys when brought to Great Britain. I presented with the specimens analyses of both, and stated the high commercial value of the alloys, which contain such large per centages of both gold and silver as to be worth about £400 per ton.

The last paper read was one by Mr. Matthew D'Arcy, whose ardour in chemical research has been directed by the instructions of our Vice-president, Dr. Apjohn. The author gives the results of two analyses—the one of the serpentine from Connemara, the other of the decomposed or weathered portion of the same rock, which had lost its colour, and in a great measure its coherence.

The author's analysis of the unaltered rock agrees generally in constituents with the published results of other chemists. The per centage of silex is, however, rather more, and that of magnesia less than usual. The per centage results are not, in either case, reduced to a formula.

On comparing the constitution of the unweathered with that given of the decomposed portion of serpentine, we find an increase in the amount of iron, and a marked decrease in the proportion of lime as well as a loss of constitutional water. The chief effect of weathering, therefore, appears to be the removal of lime by the action of air, moisture, and carbonic acid, and peroxidation of the iron attended with a reduction in specific gravity. Comparison of these analyses leads me to suppose that the determination of magnesia might require future correction.

I would draw the attention of the chemical members of this Society to the scientific interest, and economic value, and importance which attaches to the class of research, of which Mr. D'Arcy's analyses are specimens.

Our soils result principally from the decomposed or degraded, and then decomposed surfaces of the rocky skeleton of the land; a knowledge of their true constitution is of the first importance to the agriculturist. Hitherto such analyses have been almost wholly confined to soils properly so called, to those which have already been the support of vegetable life, and which have suffered further decomposition thereby.

It is, therefore, from the weathered surface of the decomposing rock itself, that we are to derive the first information as to the composition of the soil normally resulting from the rock. It is from the examination of this that we shall best judge of the rapidity of change into useful soil of the inert particles of gravel and stones that are mixed with our various descriptions of land—a rapidity by no means proportional to the mere hardness of the rock of which they consist, as will be remarked by those who have walked over the Mourne range of mountains, and observed there the depth to which the weathered surfaces of the flinty slates are decomposed into a white and friable earth. I know of no single line of chemical inquiry which can be applied to geology likely to yield a richer return, both to science and to agriculture, with little labour, than this to which I allude.

Such was the last of the communications presented to us during our past year. In the hasty glance which we have been enabled to take of their varied matter, I must apologise to their respective authors for the brief and inadequate manner in which I have been compelled to represent their leading views, praying them and all other geologists, rather to consider this as a catalogue *raisonée*, to which the future student may refer, as to a table of contents, than as a perfect digest of their researches.

During the past year, two of our members have been removed by death, Joseph Hone, Esq., a merchant of this city, and John Smith Furlong, Esq., Q.C.; neither of them were, contributors to our Transactions. The former, however, proved by his long and constant membership his sense of that duty which belongs to the wealthy—to sustain by their wealth and by the public sanction which their names and station give, the external instruments of co-operation, by which the advance of those who are really labouring for science is facilitated and hastened—an example worthy of imitation, and but too little followed by the wealthy classes in this country, both as respects our own and other kindred Societies. To one who compares the list of members of the Geological Society of London, numbering hundreds of names

of those who can assist and support science in no way but with their purses, but who do so, certain that they will not lose their reward, with our calendar of similar patronage, the disadvantage we labour under will be humbling indeed. Let us not be told this is not a rich country—upon the landowner, the farmer, the merchant, the manufacturer there are other and pressing claims—this *is* a pressing claim; for it is one of duty, nay of duty urged by self-interest.

"Knowledge," says Bacon, "is not a couch for the curious spirit, nor a terrace for the wandering, nor a tower of state for the proud mind, nor a vantage ground for the haughty, nor a shop for profit and sale, but a storehouse for the glory of God, and the endowment of mankind." I am unwilling to believe that the standard of mental culture is so low amongst the majority of the noble and higher classes of our country, that they should be insensible to these noble claims of science to their support, so far as it in them lies. I would rather hope they have not yet been fully pressed upon their notice; nor will I make science "a shop for profit and sale," by urging what any individual may gain by its patronage; but I will remind them that science is the handmaid of national wealth, the minister of national power, to the people the fit companion of education and religious truth; and as your elected president, I make bold to tell them from this chair, that in neglecting to foster and support, this and other kindred institutious, in whose co-operation the wisdom of a Bacon saw the apparatus best fitted to the support and cherishing of science, they neglect their duty, to themselves, their successors, and their country.

Our other deceased member, Mr. Furlong, Queen's Counsel, was chiefly devoted to the study of the higher branches of his own profession, upon which he was the author of some published works. He was treasurer of the Archæological Society, and possessing a highly cultivated taste, gratified it by the collection of an extensive and valuable library. Of the branches of science applicable to geology, botany seems to have been that which principally occupied his attention.

The progress of the Society, as a whole, during the past year, has been satisfactory. The members have already learnt from the report of council the state of its finances, and the accessions to its property by donations. The attendance at our stated meetings has been generally full, although we have to regret the almost continued absence of some distinguished Irish geologists, and lament that the pressure of business at a distance, or any other cause, has deprived us of the benefits of their assistance.

We hail with interest and pleasure the progress of the Geological Survey of Ireland. From the topographic accuracy of its labours, and the ability of its officers, under the able guidance in chief of

Sir Henry de la Beche, much that will be important to science, and valuable to the arts and commerce must spring; and we cannot but regard with feelings of exultation, the appointment to the command of this goodly work, of our able and zealous Secretary, Professor Oldham, as Director of the Survey for Ireland.

In the progress of such a vast and varied work, pressed on by ardent and instructed minds, it cannot be but that large accessions will be made to geology as a science, as indeed, the valuable volume of Memoirs of the Geological Survey lately published proves; but the official character and labours of the survey are essentially practical and topographic, its design is primarily to bring down the achievements of science to the social wants of man—to put us, in fact, in possession of the wealth and power with which Providence has endowed us, if we have but energy and industry to seize them. To this great end also, as well as to become an organ for the diffusion of certain classes of applied science, must the institution of the Irish museum of economic geology, under the guidance of our member, Sir Robert Kane, M. D., be devoted, an institution to whose good results we look forward with a lively hope; but, cordially working together with these, our Society must ever be viewed and remain specially the instrument of progress for geology as a science—of geology as more than a system of facts, or even of geognostic dynamics induced from them—of geology as aiming at an inductive theory of the earth, as one great chapter in the history of the universe.

It is from the conjoint labours—from the mutual helps—from the stimulus of common studies with an united interest—from the intellectual fervour of mind answering to mind in the workings of our own and other kindred Societies, that geologists themselves, are disciplined and formed, and prepared in panoply of proof to go forth the loyal knights of scientific truth.

If this be so—if it be indeed true that we form one college in the great university of inductive science—if it be also true that improved and extended education, and the diffusion of science applied to industrial arts, are means in part by which the social condition of this country may be ameliorated and raised—if there are social advantages, direct and indirect, in exalting the tastes of the middle and upper classes, by encouraging their cultivation of the natural or inductive sciences, then it cannot be out of place that we should here state a difficulty under which the progress of geology in Ireland labours—one which our unaided efforts are unequal to remove, and in which, therefore, we would humbly urge on these premises, it is fitting and desirable Her Majesty's Government should help us. This difficulty long felt, and deplored by every cultivator of geology in Ireland, is the want of a library devoted specially to geological literature, where we might refer to the many

works on our science, which are too costly for individuals to purchase, and become acquainted promptly with the vast mass of foreign geology which is contained in Continental and American periodical literature. Many of our existent libraries are not accessible to the student of geology; some, as for instance, that of the University of Dublin, do not afford to any student the advantage of a prompt supply of scientific periodical literature, and not one of our several libraries contains a complete, or even a copious collection of geological works, or receives even a moderately large fraction of the whole amount of foreign periodical science.

Having stated this primary want, I shall leave the subject here, reserving the further consideration of it to our council and officers.

We meet but four times again, gentlemen, before the close of our present session. Let me take, then, this opportunity, which the undeserved honor conferred upon me of being your leader authorises, of urging every member to endeavour, each according to his ability and power, to add something to our common stock of information, during the coming period of recess.

We have all other duties to perform, more or less onerous, that demand the larger portion of our time. Bacon complains that in all ages philosophy has never had the undivided time and attention of any man, nor perhaps would it fit our destiny that it should; but we may all add a link or two to the infinite chain of truth, if we are only so disposed and go about it the right way. Facts, which are the materials from which these links are formed, may be usefully collected by any one who will permit "his mind, like a pure mirror, to reflect nature without distortion;" but facts gathered at random are rubbish—to be of use they must be collected with reference to something, and bound up into faggots. This something is the clear conception beforehand of what we want to know; for nature's oracle is dumb, or gives no unambiguous response, but to the votary whose question is distinct and lucid, as the well of truth herself. Thus may the question be supplied by one, and the facts gathered and bound together, by many (even the humblest labourers at the temple of knowledge,) while some other mind again, uniting all their collected faggots, shall touch them with Promethœan fire, and illumine the edifice of truth with the hidden light that they contain.

This may we do. Let me then suggest for our endeavours some few leading questions which are specially answerable upon the field of Irish geology.

The vast mass of the surface of our island is covered with post tertiary gravels and clays, marl and peat; loose materials, whose history and formation have been scarcely at all investigated, whose minuter lines have been little described. Maps or good field sketches of Escars; collections of pebbles, boulders, and shells

from these, and from gravel and clay banks, and sections of the latter, are important.

Observations of the depth, size, kind, and direction of prostration of timber in bogs; of the microscopic structure of the marls and clays beneath; microscopic examination of the finest comminuted matter, (aided by acids) of the supposed *shelless* Escars in search of marine remains; evidences of the slippage or lateral transport by other means of large masses of detritus; measurement of the greatest and least volume of water discharged at the mouths of our rivers: of their cross section, and mean velocity; determination of the weight of sediment, and of soluble contents in a cubic foot of the water, (max. and min.) and if possible analyses of these: observations on the changes in organic life produced at the mouths of tidal rivers by deposits of transported matter: of what living organisms are in progress of entombment: microscopic examination, (with acids) of river muds: these and some other inquiries which I have already alluded to in the course of this address, may, and I trust will, to a greater or less extent, be made amongst us. Questions of this sort, which our peculiar opportunities best enable us to make in our own localities, constitute the proximate, though not the exclusive duty of local Societies, such as ours. Let us remember, all of us, that we do not meet here for the mere purpose of whiling away an idle hour, or of gratifying intellectual curiosity, however laudable; but that by the very act of signing the roll of membership, of this, or of any other Society, for the promotion of science, we are constituted joint trustees of the treasury of truth, and are bound to see that those talents, so far as they are committed to us, receive due increase at our hands.

I had proposed to myself in this address, to take a somewhat wider view of the progress of geology during the past year, than the retrospect of our own labours alone affords; to have noticed some of the most important accessions made during that time at home and abroad to geology as a whole, in which I must have included the recent accessions to glacial dynamics of Forbes; the views of Murchison on transported detritus—of Ramsay on denudation—of Edward Forbes on the connexion between existing fauna and flora, and geologic changes of the land—of Milne, and many others, on rock striation—of Durocher, of Jobert, and of Deville, on the formation of granite and other igneous rocks, and their vitreous relations, with many others; but I find the subject too large to enter upon, from the length to which I have already drawn upon your patience.

I could have the more desired this, because we now abide in an epoch, when the facts and first generalisations laid up and accumulating now and for the last half century, at a constantly increasing rate, and with methods better understood, and means more powerfully

applied, are rapidly arranging themselves round centres of light, in the construction of a system of geological dynamics—a system of higher generalisations—which however, are not the ultimate end and aim of our science, but the intermediate step to one true and coherent cosmical theory, to geognosy properly so called—a theory which like astronomy, its elder sister, shall look back with clear and steady eye beyond the range of all historic time, beholding further and further the bright chain of creative truth stretching away into infinite distance, and whose beginnings are held amidst "the light that no man may approach unto," by the Great First Cause—the one

. . . . . . "Omnipotent,
Immutable, immortal, infinite,
Eternal King;"

that may also look forward, and with predictive though trembling finger, and with shaded eye, may endeavour to trace "from the world that now is" the elements and boundaries which He hath ordained for the government of its future course, until, acknowledging as supreme his providence, "whose ways are in the great deep, and his paths not known," our failing intellects fall back with repose and confidence upon "the more sure word of prophecy, as of a light shining in a dark place."

"Philosophy, therefore (again says Bacon), is deservedly appointed as the true handmaid of religion—the one manifesting the will, and the other the power of God; for t'was no error in him who said "Ye err, not knowing the Scriptures nor the power of God;" thus inseparably mixing and joining together, the information of his will and the knowledge of his power."

Holding such views, we trust that the time is past, when religious prejudice arrayed itself with many, against our science in particular; that it is no longer needful for us to say, continuing the words of Bacon, "Tis therefore the less wonder that natural philosophy has not been more improved, when religion, whose power over men's minds is exceeding great, has through the ignorance and unwarrantable zeal of some been made to oppose it."

Gentlemen, our subject is vast and sublime, but it further commends itself to us as peculiarly a source of high enjoyment and mental delight. Of what other science can it be said, that it is the focus into which rays of intellectual sunshine are collected from every region of creation; which is itself "the top and round" of every natural science; which may be pursued in every climate and in every time; which may alike occupy and fill our thoughts in the studious closet, or at midnight on the darksome deep, when our stormy path is tracked in light; reposing on the "cowslip covered bank," at the wane of some summer's day, surrounded by all that is soft and gentle in "rejoicing nature round," or poised upon the icy pinnacles of earth's highest summits, where stern winter reigns

supreme; in the fainting desert, or in the dark and trackless forest; in the depths of the cavern or mine, or by the music of the hillside burn; along the sounding shore, or upon the silent mountain lake—everywhere may the eye of the geologist be filled and his mind find food. Of our science we may say in the words of the Roman statesman, but with a deeper truth than it was said by Cicero of literature—:

"Nam ceteroe, neque temporum sunt, neque ætatum omnium neque locorum; hœc studia adolescentiam agunt, senectutem oblectant, secundas res ornant, adversis perfugium ac solatium prœbent, delectant domi non impediunt foris, pernoctant nobiscum, peregrinantur, rusticantur."

JOURNAL

OF THE

GEOLOGICAL SOCIETY OF DUBLIN.

VOL. III. PART IV. 1847. No. 2.

MARCH 10th—"On the occurrence of a deposit of native Carbonate of Manganese, in the County of Clare, and on the analyses of some marls," by Sir Robert Kane, M.D., Director of the Museum of Irish Industry, Dublin.

THE place where this substance has been found is in the townland of Glandree, parish of Tulla, and in the eastern portion of the County of Clare. The precise locality is near the top of a mountain. about nine hundred feet above the level of the sea, half a mile from the small lake called Lough Ea, and on the side of a new road connecting Scariff with Gort.

The rock of the locality is the old red sandstone, from under which the clay slate rises very close by. The surface is, however, very much covered with boulders of sandstone and limestone conglomerate, and with mountain bog, so that the true disposition of the rock is very difficult to be observed.

From the cropping out of the proper rock, and the accumulation of boulders, the surface of the ground is very uneven and hummocky. In the little basins formed among these irregular undulations, there are in many cases found deposits of calcareous marl, which are very valuable to the farmers as manure, being considered preferable to pure lime, in many cases even where both are equally accessible. I have been on that account induced to examine a number of places where marl had been traced, and I succeeded in draining and opening for use some tolerably large deposits, the richness of which may be judged of by the following results of analysis, which I give merely as indicating the ordinary composition.

	Greyish Marl.	Whitish Marl.
Carbonate of Lime,	73	75
Carbonate of Magnesia,	traces,	traces.
Carbonate of Iron,	2	4
Sand, Clay,	17	10
Organic matter,	8	11
	100	100

The extensive employment of these marls rendering me naturally very anxious to find new localities of them, I took advantage of a new road having been opened through the district, during the past autumn, by the Board of Works, and had collected for me specimens of the soil and earthy materials exposed in the cutting along the line. In one place, near the summit of the mountain, about nine hundred feet above the sea, there is found under the bog, which is there about two feet thick, a layer of a yellowish grey substance about two inches thick, intermixed with the roots and fibres of the bog plants, and resting upon the decomposing surface of the underlying sandstone and clay slate rocks, the junction of which appear to be very near the spot, and which intermixed form the coarse sandy soil. This stratum of grey material could be traced for some way along the cutting of the road, and appeared to extend itself under the bog, but no methodical examination of its extent has been as yet made. On examining it with Muriatic Acid, I found it to effervesce strongly, and consequently proceeded to analyze it as a marl, but was much surprised to find it to contain a large quantity of Manganese—to be, in fact, earthy Carbonate of Manganese, with but small quantities of lime and iron intermixed. The analysis of two specimens gave as follows:

	A.	B.
Carbonate of Manganese, ...	74.55	79.94
Carbonate of Lime, ...	a trace	2.43
Carbonate of Iron, ...	15.01	11.04
Clay, Sand, ...	0.33	0.37
Organic matter, moisture, and so on,	10.11	6.22
	100.00	100.00

The Carbonate of Manganese is known to be one of the rarest forms in which this metal occurs, and it is mentioned in the standard mineralogical works as occurring only crystallized. I do not find an earthy Carbonate of Manganese any where distinctly noticed. The present form may therefore be possibly altogether new to science; but certainly it has not been found constituting a marly deposit of this kind in any other locality. In no form had this mineral been previously found in Ireland.

The sandstone rocks of this district are very generally tinged brownish with Manganese; but I have not been able to find any evidence of the existence of the Peroxide in any deposits or veins of commercial interest.

I have had occasion to remark, that if air be excluded the Carbonate of Manganese will bear a very high temperature without being decomposed. Thus if it be ignited, packed in a deep crucible, the atmosphere of carbonic air, formed by the decomposition of a minute quantity, will perfectly protect the rest, except at the surface; so

that if the crucible be left to cool undisturbed, the mass of carbonate will be found unchanged. This fact, which is analogous to the known property of carbonate of lime, may be useful in considering the formation or existence of Carbonate of Manganese under certain geological conditions.

Mr. Oldham submitted to the Society the results of the fusion of some trappean and other rocks, from the County of Wicklow.

He stated, that while recently in London, he had made some experiments in fusing some of the rocks from different parts of the County of Wicklow. The specimens experimented on had been reduced to powder in a mortar, and placed in common Cornish crucibles, and submitted to the intense heat of a strong laboratory furnace, at the Museum of Practical Geology, which was continued for some time; the crucibles were then removed, the whole allowed to cool rapidly, and then broken across; one half of the crucibles with the fused portion of the mass, being submitted to the Society, along with specimens of the rock in its natural state.

The first specimen was from the parish of Dunganstown, and was what is frequently described as talcose slate; it is of a yellowish light green colour when freshly broken, soapy to the touch, and composed of numerous thin laminæ of a talcy or steatitic mineral, alternating with siliceous and compact felspathic laminæ. A portion of this rock being reduced to powder, was packed in a crucible, and submitted to the heat of the furnace for more than an hour, when on examining the mass after cooling, the result was a very compact vitreous looking mass, similar in aspect to vitreous looking quartz rock, but full of air bubbles, probably from the fusion not having been continued sufficiently long. It is worthy of note, that in making this experiment, a sufficient quantity of the rock not having been reduced to powder in the first instance, the crucible was allowed to stand for some time, while an additional portion was being prepared; this was then added; and although the whole mass is firmly united and run together in the crucible, still the line of division of the two portions successively put into the crucible, is quite perceptible.

A portion of syenitic greenstone, from the West Aston Hills, was also fused. In this rock, the hornblende and felspar appeared to be in nearly equal proportions, with a little free quartz, and a few small crystalline plates of a brown bronzite looking mica; the whole highly and beautifully crystallized. This reduced to powder, was submitted to a similar heat for about one hour and a half, when the result proved a very dense and compact black glass, in which were disseminated small portions of a white substance which proved to be silica, giving to the whole a pseudoporphyritic aspect. It is probable that these were the unfused particles of quartz existing in the original rock, and which may possibly not have been reduced to as fine powder as the other ingredients.

A third rock was of a compact felspar, having a few crystals of felspar imbedded, of a dark green grey colour and very dense. This on fusion yielded a spumous dark brown, approaching to black, glass, having some minute specks of a whitish mineral disseminated, which appeared the unfused grains of some portion of the rock.

A fourth was a crystalline diallagic greenstone, the paste of which was composed of a subcrystalline diallagic greenstone, with large crystals of bronze coloured mica imbedded. This proved refractory, and on removing the crucible, after continuing the heat for about an hour and three quarters, only a part of the mass was found to have been fused, and this not perfectly; the whole had, however, been solidly compacted into a spumous enamel, of a brownish black colour.

These results were only submitted as provisional, the experiments having been rudely conducted, and merely with a view to show the possibility of fusing many rocks, (which might appear very refractory) at temperatures not exceeding that readily attainable in ordinary furnaces. The author stated, that further experiments would be made, and care taken to ascertain the change in density of the rock, when it has passed from the crystalline to the vitreous state. It is difficult to obtain perfectly accurate results in such experiments, from the circumstance that the crucibles themselves exert a considerable influence on the result.

April 12th—"On a variety of Hyalite, from Mexico," by James Apjohn, M.D., Professor of Mineralogy to the University of Dublin, &c.

The specimens examined, were presented to the University Museum, through Mr. Ball, by Professor Radice. They form detached mammillary masses, highly transparent, of specific gravity 2.1016; more frangible than quartz; exhibiting slight conchoidal fracture; harder than glass, but scratched by steel.

On careful analysis it was found, that although it thus resembled other varieties of hyalite, it contained much less water. The mean of four analyses gave—

Silex, ...	97.48
Water,............	2.52

corresponding accurately with the formula—

$$15\, S\, O_3\,,\ 2\, H\, O.$$

The amount of water is thus not more than two fifths of what has been found in the least hydrated variety of hyalites, the analysis of which has been published, which varies from five to ten per cent.

But its optical properties are still more remarkable. In all treatises on mineralogy, hyalite is stated to be singly-refracting; but on transmitting through the Mexican hyalite, a ray of plane polarized light, and examining it with a an analyzing eye-piece, it was found to possess, in a very marked degree, the property of depolarizing the ray. The action, however, appeared of an anomalous kind, for while in all doubly-refracting crystals, whether uniaxal or biaxal, there are two positions of the crystal, in which, if interposed (for example) between two tourmalines whose axes are crossed, the light continues excluded, there is no position into which a lamina of this hyalite can be brought, by revolving it in its own plane, in which the light will not be restored.

The action, therefore, of this mineral on polarized light is not of the ordinary kind, and can, as far as my knowledge of this difficult subject extends, only be explained by supposing that, like rock crystal in one particular direction, and certain essential oils, and aqueous solutions of sugar, dextrine, &c., it possesses the power of changing the position of the plane of polarization of a plane polarized ray, or of causing it to revolve through a greater or less angle. This view would seem to be corroborated by the following experiments.

1. A ray of homogeneous red light was made to pass through a lamina of the hyalite, on which nearly parallel planes were cut and polished, this lamina being interposed between a pair of crossed tourmalines. The light was thus restored, and, by rotating the tourmaline next the eye to the *right*, it was again very nearly extinguished.

2. The preceding experiment was repeated with yellow light, got from a spirit-lamp with salted wick, and with the same results.

3. Upon substituting for the light of the spirit that transmitted through a window-blind of a yellowish colour, the phenomena of the last experiment were very distinctly reproduced.

4. In operating, by the aid of the apparatus used in the preceding experiments, with heterogeneous or solar light, and making the analyzer revolve, a series of tints were produced, much feebler than those exhibited by quartz, but following apparently the same law.

From these facts, I think I am justified in concluding, that this hyalite exercises the power denominated rotatory polarization. This property, too, it possesses, no matter in what direction it is traversed by the plane polarized ray, a circumstance which would seem to identify it with that exerted by liquids, and distinguish it from the analogous influence of quartz, which is manifested only in the direction of the optic axis.

P.S.—Since the preceding remarks were put together, I have found that a ray of light polarized by reflexion, and made to disappear by the interposition of Nicholl's prism, was restored when made to pass through a particle of hyalite from Frankfort on the Maine.

All varieties, therefore, of this mineral may be concluded to possess the same optical properties.

In respect to the experiments above detailed, I have found that the results are somewhat different, according to the part of the lamina of hyalite traversed by the light, the change in the position of the plane of polarization not having always the same direction or value, and being sometimes null. This fact would seem to point to a different explanation of the phenomena from that already suggested, and to identify the optical characters of hyalite with those of rock crystal, the differences being explicable upon the hypothesis of the former mineral being composed of a multitude of minute crystals of the latter, thrown together without any regular or symmetric arrangement.

The two first sheets of the sections of the Geological Survey were exhibited on the part of Professor Oldham.

May 12th.—"Notice of erratic blocks of greenstone, occurring in the neighbourhood of Bandon, County Cork," by G. J. Allman, M.D. Professor of Botany, Trinity College, Dublin.

These are found lying on the carboniferous slate, the rock of the district, and are scattered over an extensive area. Their chief locality, however, is in a small valley, which runs nearly east and west, about two miles to the north of the town. They occur here in very large rolled masses, some of the blocks weighing several tons.

"On erratic blocks, and the causes of their distribution," by R. Mallet, Esq. Ph. D. &c. President of the Society.

The printing of this paper is postponed until it be concluded.

June 9th.—"On pseudomorphous crystals of mica," by T. Oldham, Professor of Geology to the University of Dublin.

Many years since, during a brief visit to Glandelough for other than geological purposes, I was much struck by finding in the vicinity of Lougnahanagan, a small lough on the northern slope of the hill over the lead mines of Luganure, (Camaderry Mtn.) some tolerably large and well formed crystals, somewhat worn on the outside, but presenting all the appearance and form of andalusite. They were of a dark grey, or lead grey colour. Finding at the same time some large specimens of this same mineral, of the ordinary brown colour, of which it occurs in the County of Wicklow, I at first supposed

that the others were also andalusite, the difference in colour arising from exposure; but on more carefully looking at them, and on breaking them across, I found that although the form was that of andalusite, still the prism was made up of an aggregation of small crystalline laminæ, of a dark lead grey pearly mica. I could not at the time, being hurried, find more than a few of these crystals, and have not since had an opportunity of revisiting this locality, but have not forgotten this interesting case of pseudomorphism.

However, during the examination recently of the hill of Keadeen, in the vicinity of Baltinglass, where the slates, resting on and associated with the granite, are so altered, as in many parts to be composed almost entirely of this andalusitic mineral, I naturally turned my attention to seeking for some traces of a similar pseudomorphism to that which I had before noticed, and I was enabled to verify the observation more satisfactorily than I expected.

Perhaps the small stream, which forms the source of the Derreen river, and flows down the southern and eastern slope of the hill called Slievereagh, forming the long eastern shoulder of Keadeen, offers the best opportunities of studying the changes which have taken place in the slates, as we can see them in connection with numerous intruded veins and masses of granite of various sizes, and occurring in various relations with the slates.

The slates are here very highly altered, they are very micaceous, the mica being of a pearly grey, or a lead grey, with bright silvery metallic lustre; and they are full of andalusite, varying in size from that of fine needle-like crystals, to prisms half an inch across, by four or five inches in length.

In some of the layers these crystals, retaining all the outward form and appearance of those so common in the neighbourhood, are found either *partly* or *entirely* replaced by mica of the same pearly and talcose character as that which characterises the slates; every stage in the process of replacement being traceable, from the thinnest film of mica on the outside to the final replacement. This may be well seen both on the longitudinal and the transverse fracture of the crystals, forming very beautiful and interesting specimens.

The regularity with which this replacement has taken place, the line of junction being very even, is remarkable.

To this observation I shall not add any minute description of the appearance observable in the slates adjoining, but simply state the facts.

1st.—These crystals occur on the laminæ or folia of the slates, being entirely absent from some, while others are completely covered with them—the result obviously of a difference in original composition of the layers.

2nd.—They sometimes occur in nodules, being absent, or at least comparatively so, from the adjoining portions.

3rd.—They are more abundant where the slates are associated with thin or thicker layers of siliceous gritty or sandy beds.

4th.—where these grits are absent, and the slates are more argillaceous, they are highly micaceous and silvery.

5th.—They (the crystals) are frequently not perfectly formed, the angles being, as it were, rounded off.

6th.—An important fact is that these crystals are themselves often traversed by thin films of mica, forming, as it were, a sort of cleavage.

In colour they are of a dark grey, with a tinge of brown.

Such are some of the principal facts. They point to a succession of operations involving the consideration of a period of great length; and showing also, that the metamorphism of these rocks has been a long continued and gradual process, and that the condition in which we now see them is the result of many varied and successive operations.

It is only right to notice, that Mr. Weaver, in his valuable paper "On the geological relations of the east of Ireland," with his usual acuteness has noticed, (Geol. Trans. 1st series, Vol. 5, page 45,) that "the characters of this substance (andalusite) are subject to great variation from a more or less intimate incorporation with mica," although he has not noticed the peculiar mode of their connection.

"On certain peculiarities in the lamination of the slates of the south of Ireland, and on the physical conditions of the slate formations," by Robert Mallet, President.

The general direction given to our conclusions, from all the evidence we possess as to the great slate formations, is that they have been deep sea deposits, slowly formed in waters comparatively tranquil. The discovery of ripple marks, therefore, in the ancient slate beds, is a matter of interest; and although these have been very frequently sought for, and their occasional existence declared, some doubt has always existed as to the true nature of the markings so taken for ripple mark; and the physical conditions under which some localities in a great deep sea deposit, may be characterised by ripple marked beds, do not seem to have engaged much attention, or to have been explained.

The author about three years since remarked with interest, the occurrence of ripple marking upon the slate beds at several points in the valley of Glengariff, in the south-west of the County of Cork; and much more recently has observed ripple mark of the most undeniable and well developed character, upon the slate beds, exposed in nearly a vertical position, upon the north side of the road leading from Macroom to the City of Cork. The author regretted the impossibility of exhibiting any specimen from either of these localities, to the Society; no specimen of less than a yard or more square, would present surface sufficient to judge of the character of the markings, and he had no means of detaching or removing such slabs.

The author has remarked that ripple marked beds are comparatively rare amongst the slates; the great mass of the slate beds are found bent, twisted, and doubled up in the most capricious forms, but true ripple mark is very rare; and—so far as the author's observations in Ireland are concerned—are seldom if ever found in the slate beds of a dense argillaceous or arenaceous character. Wherever the ripple marked beds occur, there the slate is of a magnesian or micaceous character.

This circumstance led the author to consider what might have been the physical conditions of deposit of the materials of the slate beds, which—admitting them to have been upon the whole deep sea deposits—could account for this occurrence of ripple mark, in connexion chiefly with the more micaceous beds of slate; and pursuing the train of thought thus started, he has been induced to form some conclusions of a more general and comprehensive nature, as to the slate formations of Ireland considered as a whole.

The slaty rocks of Ireland, however various in geological or stratigraphical position, or in texture and composition—whether the fine smooth blue, grey, and green roofing slate; or the coarse, arenaceous, gritty green, grey, or red slates of the south west; or the micaceous, or quartzose, or porphyritic slates of Wicklow; or the argillaceous beds of Carlow and Kilkenny, or of Clare—must all be viewed *lithologically*, as associated rocks. It is part of the author's present object to endeavour to show, that not only these, but the mica slates and quartz rocks are probably geologically associated; that the formation of the quartz rocks—masses of siliceous sand, gravel and rolled pebbles, cemented or baked into coherence—of the slates, whether argillaceous or arenaceous, and of the mica slates, though not contemporaneous throughout—has been due to the long continued action, upon a vast scale, but at different epochs, of one class or system of forces.

In passing through any one of the great slate countries of Ireland, we not only find continual variations in the texture of the slates, a greater or less admixture of sandy particles, now become quartzitic, in larger or smaller crystals, but we find the argillaceous slates passing insensibly here and there into mica slates, and both passing into quartz rock, which (with boundaries, however, pretty strongly marked,) is almost always found in large irregular masses, associated and bedded with the slate formations.

The slate beds themselves, especially in the County of Cork, frequently contain minute imperfectly rounded quartz pebbles, embedded in the general sandy mass.

Reviewing, then, the whole of the phenomena of deposition, composition, and structure, presented by the above associated rocks in Ireland, the author is disposed to consider them as due, in each separate formation, (*terrain*) to the sorted deposition, from water of the detritus of the older rocks (siliceous, argillaceous, and mag-

nesian) of a vast ancient continent—detritus brought down, either by great rivers, and by them ground, sorted, and deposited beyond their mouths, or ground, sorted, and deposited by tidal action, accompanied by sea currents, beyond their estuaries. The peculiar character of sorting and deposition, which the author conceives the slate formations present evidence of, upon a colossal scale, he had recently an opportunity of observing as actually taking place daily, though upon a comparatively very small scale, in the upper lake at Glandelough, Co. Wicklow; and the circumstances under which the deposits are taking place in this lake, seem so instructive, that their description will best suggest the views which he takes as to the nature of the actions, altogether similar, but upon a far greater scale, by which he conceives the micaceous slates, the argillaceous slates, and the quartz rocks have been formed.

The upper lake of Glendalough lies in micaceous and arenaceous slate, surrounded by precipitous mountains; the small river, Glenealo, enters the lake at its upper end, coming from a lofty table land of granite overtopped by summits of granite; the flow of the river is from west to east. At about a mile above the western end of the lake, the stream begins to fall with great rapidity, and within half a mile it descends in almost a continuous cascade, from a height of more than twelve hundred feet above the sea, to within a few feet of the level of the surface of the lake, which is about four hundred and forty feet above the sea level, (ordnance datum.) It then flows in a sinuous and gentle stream, for above a quarter of a mile, through a nearly level bed of alluvium, which forms a strikingly secluded and picturesque haugh, or flat, at the extreme upper end of the valley of Glendalough, environed upon every side by precipitous rocks, and inaccessible from the valley in any direction, but by a single path, which winds along the northern, and rapidly sloping side of the lake.

The lake itself is nearly a mile long from west to east, but not above one sixth of a mile wide; its deepest parts are along its southern shores, from St. Kevin's bed westward, and at its northern shore, close to the western corner. The extreme east end, and most of the northern shore, on the contrary, are shallow.

If, now, we commence our observations at the head of the cascade of the Glenealo river, we shall find the stream bringing down a large quantity of detritus from the quartzite and slate rocks above. Searching in the bowls or basins formed in the rocks by its descent, we shall find this to consist of coarse angular fragments of disintegrated granite, quartz, and felspar, but chiefly the former—of fine sandy particles of the same—of a fine dense, but impalpable mud of ground slate, highly argillaceous, of a greenish gray colour, and which when deposited quickly consolidates in a dense pasty cement—and lastly, of light micaceous and schorlaceous particles, mixed more or less with the former, and with very fine siliceous sand.

As we now descend the stream, and visit its *debouchure* into the

lake, we find a bar formed at its mouth, composed wholly of loose particles of the disintegrated granite, and the slate of fine gravel and sand. This bar is of a crescent shape; it extends some hundred feet in length and breadth, and is deposited much more to the northward of the mouth, than to the centre or south of the stream, (owing to a cause presently to be adverted to.) It falls into very deep water, and is so loosely coherent, as to be extremely dangerous for those who are not swimmers to walk upon at all near its outer margin when dry, as some two acres or so of its surface are in summer; for I found that great masses of it could be put into motion at once, and caused to slide with the person standing on it at once into the deep water. As we always find, the coarser particles of this bar are next the stream, and down its outer talus, and the finer particles in its centre, and along the crest, save where the surface is swept over by the waves in winter.

If we walk along the southern shore of the lake, towards St. Kevin's Bed, or examine this shore from a boat, we shall find the water generally deep, and no deposits taking place, except in some sheltered nooks or bays; but if we pass from west to east, along the northern shore, we find, after we have got about one-third of the way down the lake, that a large deposit of dark grey and greenish argillaceous mud is being deposited along the shore. This is visible wherever the water is shallow, and here the mud is all ripple marked; it is especially observable at and about the centre of the north shore. Passing from west to east we find the fineness of this deposit constantly increasing; for a considerable distance eastward of this point we lose sight of it; and when at length we arrive at the extreme north-east extremity of the lake, we find a deposit taking place along the shore, partly of the very finest argillaceous mud, mixed with a great deal of mica, but principally of small scales of mica and schorl alone. These are ripple marked too; but the slightest agitation disturbs the particles, which instantly diffuse themselves through the amber coloured water, causing it to glitter for yards away, as though full of gems and gold, and remaining in suspension for a great length of time.

At or near this corner of the lake, its effluent waters pass quietly away, with very little fall into the lower lake; and between this point, returning towards St. Kevin's bed to the south-west, along a dry and stony shore, which slopes at first gently, and then plumps down into deep water, we find no deposit of any sort occurring, except those due to the detritus brought down by the Lugduff brook.

The lake, then, is a great and deep basin, as compared with the streams falling into it, through which, from west to east, a slow and gentle stream is constantly passing, and bringing down the solid matters already described.

Let us now remark, that owing to the configuration of the mountains to the westward of the lake, the prevalent west wind of Ireland

becomes here diverted into a wind a few points to the south of west. This direction also gives the usual and prevailing direction of the superficial currents of the lake, due to wind, and of the waves that are formed upon its bosom, which thus, rising at its south-western extremity, pass along, breaking with extreme obliquity upon the northern shore, along its whole length.

In the conjoint action, then, of the Glenealo river, feeding the lake with water and detritus, and of the sorting action of the slow stream in the whole body of the lake itself, and of the superficial wind currents and the waves, we have the mechanism by which three several and separate deposits are taking place at the same time, in different parts of the lake, which represent, separately, the quartz rock, the elements of which are found, though not yet compacted, on the bar, at the western end—the argillaceous and arenaceous slates, along the shores, about the centre—and the micaceous slates, as along the shores further on, at the east end, or north-east end.

We have all these separated and formed from the single mass of mixed matter brought down into the lake; but further, we have these deposits, no doubt, at the bottom of the lake, and in its central and deepest portions, as well as at the point stated; for the sedimentary matters cannot have reached these distant shores, without much of their heavier portions having been dropped in the deep water intervening. But the deep water in the central abysses of the lake is far beyond the reach of surface agitation of any sort, hence these deposits here must be smooth, level, and stratified; so that we have in this same small basin, deposits actually taking place of the same materials, differing only, and but very slightly, in the size of particles, which are ripple marked upon the shores, but are smooth, bedded, and devoid of ripple mark in the central portions of the lake. We have, therefore, imitated here, as in a working model of nature's own construction, all the phenomena of formation of the slate countries. We have the quartz rock—the slates, arenaceous, argillaceous, and micaceous; and we have them principally deposited smooth and unruffled, but in some localities ripple marked. We have but to enlarge the Glenealo to a vast river, the drainage of a great continental tract—the lake to a capacious gulf, or sea, and each of its deposits to the size of a country or a province, to give us the circumstances of the slate formations as we find them. Vast changes by upheaval, setting over, denudation, and all the immeasurably slow molecular phenomena resulting in lamination and cleavage, &c. have subsequently taken place, but with these we are not now concerned. These changes have been so vast, that it may be for ever a hopeless attempt to discover and map, from the present circumstances and position of any given slate formation, the position, relation, and circumstances of the sea within which, and the river or rivers by the detritus of which it was produced; but the view now advanced will afford some leading lights to any such trial. For ex-

ample: wherever we find the slate beds without true ripple mark, we may be pretty sure they were deposited in deep water; wherever we find the ripple marking, we may conclude the deposit to have taken place in shallow water, and either close to a shore, or in a shallow stream-way.

Again: the arenaceous slates must have been deposited nearer the detrital source than the argillaceous slates, and these still nearer than the micaceous slates.

It forms no part of the present paper, to enter minutely into the physical circumstances concerned in the production of ripple mark as we daily see it—a subject, however, of great interest, of considerable complexity and difficulty, and one upon which no accurate or consecutive researches have been as yet made, so far as the author is aware. He promises himself the making a future communication on this subject, meanwhile observing, that whatever be the precise mechanism of the production of ripple mark, its occurrence seems to require either the presence of small surface waves of oscillation—whose dimensions must not greatly exceed a few inches from summit to summit—and on water, whose depth does not exceed a few inches; or the presence of fixed obstructions in an uniform stream-way, giving rise to short undulating waves, commencing at the bottom, and propagated down the stream from the obstacle. These, upon a suitable bottom, give rise to ripple mark at considerable depths.

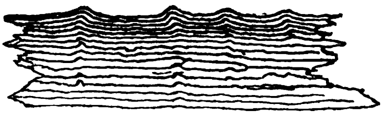
When a shore is a very gently sloping flat of sand, such as is a large portion of the shores of Dublin Bay, and when the extreme limit of high and low water comprehends a vast tract of ground, laid dry at every ebb, it is obvious that ripple mark may be found over the whole of such a tract; every portion of it being in its turn immersed, at flow and ebb of tide, in water sufficiently shoal for its production; hence, *cœteris paribus*, the extent of ripple mark is a measure of the abruptness or otherwise of the shore upon which it was once formed. It is also manifestly an index of the direction of prevailing small surface waves; which depends, not only upon the general line and trending of the shore, but upon the prevalent direction of motion of the larger sea waves further out, whose fragments, as it were, these smaller waves are, and also upon the direction of prevailing winds.

The most perfect and remarkable examples of ripple mark which the author has observed in Ireland, are upon the argillaceous flags of Carlow and Kilkenny, of which some fine specimens exist upon the high road from Kilkenny to Carlow, near the Royal Oak.

Between Kenmare and Glengariff, also, ripple mark occurs, of a small sized fret; the size of the fret is much larger, as observed on the road between Macroom and Cork, near Ballincollig. It is occasionally, but very rarely, observable on the calp beds of the County of Dublin. Some fine specimens did, and perhaps do still exist, in detached blocks, in the bed of the river Dodder, close to the weir at Fir

House, where other blocks of calp occur, also presenting the remarkable circumstance of containing large rounded embedded boulders of pure limestone, of a light grey colour; the boulders are five or six inches in diameter, and the author could not find any fossils by which their parent rock might be identified.

A phenomenon of weathering occurs upon some of the slates in the south of Ireland, that may be readily mistaken for ripple mark. The chloritic slate weathers fastest; it possesses two distinct systems of cleavage—a greater and a lesser, whose planes are nearly at right angles to each other. When either of these lies in the line of direct water-shed, and at right angles, or nearly, to the surface of the rock, weathering of a peculiar character is produced. Thus when the lesser cleavage is so posited, waved lines of projecting ridges, not sharply defined, but rounded, and very likely to be mistaken for ripple mark, result. Thus:—

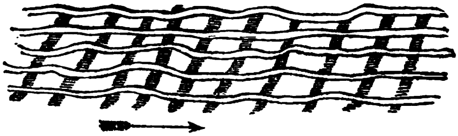


When the plane of greater cleavage is in the line of water-shed and nearly perpendicular to the surface of the rock, the weathering takes place in such a way as to produce appearances of the most deceptive kind, narrowly resembling scratches produced by the passage of solid masses.

There is another appearance sometimes, but rarely, presented by the surfaces of the beds of calp in various parts of Ireland, closely resembling a colossal ripple mark, in which the distances from summit to summit of the rolling wave-like surface, is from two to eight, or ten feet, and the depth of the trough often eighteen inches. An example of this may be remarked in the bed of the Liffey, at Dublin, just below the Poddle junction, at very low spring tides. This is certainly *not* ripple mark; and whether it be due to contortion, by unequal pressure of the as yet unindurated beds, or to some peculiar undulatory movement in the fluid from which they were deposited, future observations must decide.

Lastly, another class of corrugations are observable upon very many of the slates in Ireland—occurring very palpably in the County of Wicklow, upon the micaceous and argillaceous slates—which is at the first glance so like ripple mark, as to be easily mistaken, and yet which is not so. This presents itself in a very singular wrinkling of the beds, in lines of fret, which die out at intervals, longer or shorter, when seen perpendicular to their beds, and having plane or flat spaces, or often gently curved spaces between, so that a section

at right angles to the plane of the beds, is something of this form:—



Line of Water-shed, and of lesser cleavage.

The character of these wrinklings, when seen on the flat of the beds, forbids the idea that they are due to end on compression; neither are they ripple mark, for which they are far too sharp and small, and the spaces between disproportionate in breadth, and incompatible in form.

The observation of their occurrence, and the difficulty of giving a rationale, struck both Professor Oldham and the author about the same time.

The author is disposed to attribute those singular wrinklings to slow internal movements having taken place, by slippage or subsidation of the semi-fluid slob, of which those micaceous slates were formed, prior to induration. Such semi-fluid masses, when in very slow but continuous movement under water, would in fact contain forces of unequal extension and compression within them, quite analogous to those of a glacier; and while crevices would abortively be formed in their masses at right angles to the lines of greatest extension, which would directly be filled in again by the plastic mass; so lines of maximum pressure must exist parallel with the lines of crevices; and in these lines the fine beds of micaceous mud may be conceived to have wrinkled in the way described. This wrinkling would be parallel with the general line of motion of the mass; but where the mass, simultaneously in movement, was of great depth, the velocity at the upper and lower parts would differ much, even though the whole were not confined in any bed or channel like a glacier, but was merely a great bank of slob, sliding slowly out into deeper water, in virtue of the continual accumulations upon it from above. This difference would produce differential motions between the upper and lower beds, which would result in such wrinklings also; but in this case these would lie at right angles to the general line of movement. These corrugations, or wrinklings, so far as the author has observed, lie on the slate rocks of Wicklow in one direction, at a given spot, but vary in every possible direction at different localities; that the beds of slate may have also been greatly twisted and contorted in mass, by such semi-fluid sliding movements is very probable. Indeed such seems a much more generally probable form of that end on compression, first suggested by Sir James Hall, as the physical cause of contortions, than many of the other sorts of mechanism that have been called in to account for the way in which the end on pressure was produced.

In fact such contortions from precisely the forces here indicated, are constantly observable, when large masses of the variegated clays of the London basin are thrown out in heaps, as in forming a large embankment. When this is subsequently cut into, the tinted bands are found twisted and wrinkled very curiously by the intestine semi-fluid movements of the mass, in progress of consolidation and settlement by its own weight. The bandings are here, however, too irregular and ill-defined, to evidence the wrinkling due to differential motion, as here peculiar to the slates.

November 8th—"Remarks on the Geological Sections exposed by the cuttings on the Dublin and Drogheda Railway," by George V. Du Noyer, Esq.

The abstract of this paper is given, with its continuation, in report of meeting for December 13th, infra.

"On a remarkable group of the remains of deer found near Kiltiernan," by Professor Oldham, Secretary of the Society.

The cotton mills of Mr. Moss, the paper mill of Messrs. Mahon and Brown, and the lead works of the Mining Company of Ireland, at Ballycorus, being deficient in water-power during the summer, a water-course of about one mile and a half in length was commenced seven months since, through the bog at Ballybetagh, in the parish of Kiltiernan, in order to bring an additional supply of water. All the parties interested subscribed to the useful project, and the entire work has been commenced and completed under the superintendence of Mr. Sigismund Moss, who undertook the management without any emolument.

During the progress of the cutting, which in parts was twenty-one feet in depth, the heads and antlers of some thirty elks have been disinterred, and most carefully preserved by Mr. Moss. The first found was discovered about eight feet from the surface—being about four feet of bog, two feet of gravel and sand, and two of a kind of vegetable compost, containing leaves, grass, and mud or fine granite sand, with mica. The entire number (thirty) found within a space of a hundred yards in length, by four yards wide, were, without exception, found embedded under the turf in the vegetable compost; the two being divided by a thin bed of fine sand. Under this vegetable compost, was a blue putty-like marl, about nine inches deep, forming a bed over blue marl of a more solid character. There were many large bones, ribs, femur, vertebræ, &c. found, all of which lay detached, but no perfect skeleton.

Mr. Oldham stated that, by the kindness of Mr. Moss, he had been enabled to see two of the heads actually dug out.

But the most interesting circumstance connected with this group of cervine remains was the discovery, lying close and touching the others, of the heads of the reindeer, in excellent preservation, the horns being very perfect and large: there was also a lower jaw. The author pointed out the peculiar character of these horns, as distinguishing them from all the others, and stated that this discovery was peculiarly interesting, as being the first well-authenticated instance of the occurrence of the reindeer in Ireland.* In Mr. Ball's very valuable collection of natural history, which now adorns the University museum, there is a fine head and horns of a reindeer, which had been given to him as being found near Youghal, but which, from careful examination, he had always considered doubtful. And in a collection of the remains of deer in the possession of Mr. Glennon some time since, Mr. Ball also informed the author that he had seen a fragment of a horn, which, perhaps, belonged to this species, and which was said to be Irish. But these two doubtful cases, neither of which had been recorded, were the only ones known; and even in England, the evidence of the former existence of the reindeer in that country, as given by Professor Owen, in his report on British fossil mammalia, rested on two much broken specimens. The heads, therefore, now exhibited to the Society, were not only the first authenticated instance of the occurrence of such remains in this country, but also by far the best evidence yet discovered.

Professor Oldham briefly pointed out, by a reference to a map of Europe, the present distribution of the Cervus Tarandus, and contrasted it with the former distribution, as evidenced by these remains.

"On a substance externally resembling Bitumen," by George V. Du Noyer, Esq.

During a recent geological examination of the Midland Great Western Railway, between Dublin and Enfield, the author in examining the cutting at Cappa Bog, parish of Cloncurry, County of Kildare, three miles on the Dublin side of Enfield, detected this bituminous-looking substance in the upper portion of the limestone drift gravel underlying the bog; and as there are other curious features observable in this cutting, he brought the matter before the Society, with the kind permission of Professor Oldham.

A drawing of the cutting was exhibited to the Society, and the author remarked, that a layer of bog, varying from four feet to one foot in thickness, rests on the drift limestone gravel. In the bog itself there are several irregular masses of gravel and sand, the most superficial of which appears to be a portion of the stuff thrown up when the adjoining canal was being constructed. The upper surface

* Mr. Richardson has incidentally mentioned the occurrence of a few bones of the Rein-deer, among other bones found at Lough Gur.—*Zoologist*, 1846.

of the drift gravel, when in contact with the bog, has undergone a most singular alteration; to the average depth of two feet, it becomes more clayey, and the limestone pebbles enclosed in it, though retaining their irregularity of form, and somewhat their natural colour, have been changed to a complete rotten stone, deprived altogether of their carbonate of lime; lumps of fossiliferous limestone have been rendered cellular by the softer portions of the fossils having been removed; occasionally when a limestone block is tolerably large, the surface alone is decomposed in the way described, and frequently when a fresh cutting is made, a lump of limestone will be found in the state of absolute mud. Green-stone pebbles, when they occur, crumble into fine fragments on being struck with the hammer, the quartz pebbles alone retaining their original hardness. In this rotten layer we find masses of this bituminous-looking substance; they are variable in size, the largest being about seven inches in diameter, and many are found to contain a small lump of decomposed stone. Sometimes this bituminous matter assumes the appearance of seams, running irregularly through the layer, which contains the decomposed pebbles; in one spot it is seen to coat the sides and roots of a tree-stem which stands erect in this rotten gravel.

This substance is of a jetty black colour—soft and spongy when first removed from the gravel, with a conchoidal fracture. When exposed to the drying effects of the atmosphere, it becomes hard, and breaks into angular pieces. Before the blowpipe in glass tube if regularly heated, without being brought to a red heat, it loses its colour but slightly, becomes more brown, and breaks up into small fragments, losing a very large proportion of its volume. When heated to dull redness it does not blaze, but passes into a white ash, with a very slight disengagement of a whitish smoke, emitting a smell of burnt wood. So far as I am able to pronounce, it appears to be decomposed vegetable matter, prior in growth to the superincumbent bog, and which was drifted with the gravel.

The bog which overlies the rotten gravel containing this bituminous-looking matter is of a light spongy nature, consisting almost entirely of decayed grasses and marshy plants, arrayed in regular and horizontal laminæ, and having scattered through it small branches of trees, which increase in number and size in the lowest stratum, where they are associated with large blocks of timber and roots of trees, apparently those of the fir, birch, and hazel.

The gravel which is interstratified with the bog is precisely of the same character as is ordinarily the case.

December 13th—"Remarks on the Geological Sections exposed by the cuttings on the Dublin and Drogheda Railway," by Mr. Du Noyer, (Geological Survey.)

The author commenced by stating, that having just completed for the Government Geological Survey, an examination of the cuttings afforded by the Dublin and Drogheda Railway, he was enabled, through the kindness of Professor Oldham, (Director of the Geological Survey of Ireland,) to submit the result of his work to the Society.

The sections which railway lines afford, though most generally of inconsiderable depth, and often far apart from each other, are likely to be of much value to the geological inquirer; because, occurring on the least elevated grounds, and those most free from superficial impediments, they expose what otherwise might be completely hidden, or but imperfectly seen, and thus many new facts of geological value may be brought to light, or doubtful points rendered more easy of being understood or explained.

The rocks are first seen at Killester, about eighty feet on the Dublin side of the second mile post; the beds are nearly horizontal, dipping to the S.W. at an angle of about 5°. Over them are from two to four feet of stiff brown calcareous gravelly clay, the upper portion of which contains sea shells. At Killester Bridge we meet "the Black Quarries," as they are termed, where a good section of the calp limestone and shales is exposed. There are three small breaks observable in the strata at this quarry. At the N.E. extremity of these quarries, where the depth of cutting amounts to about thirty feet, the floor of the quarry consists of a layer of crystalline limestone, resting on black earthy and slaty limestone; over the former are black slaty beds, containing impressions of plants with spirorbis, some minute pectens, and impressions resembling goniatites; general dip of the beds S,W., at an angle of from 3° to 5°, which increases rapidly to the N.E. At the distance of about three hundred and eighty feet from this quarry, the limestones and shales are again met with at Killester Bridge, but here subjected to much pressure, and curiously contorted. These contortions have been well illustrated by G. W. Hemans, Esq. who was engineer to the works.

In some of the hardened shales at Killester there were impressions of plants and pectens, similar to those noticed as occurring at the Black Quarries.

On a close examination of the Killester rocks, it will be observed that frequently the thin shale partings exhibit friction marks, and marks of compression, apparently dependent for their character on the thickness of the shale, and on the manner in which the accompanying hard layers have been contorted, displaced, or compressed. Thus, when the shale is very thin, and the associated beds have been curved over, the surfaces are marked by fine corrugations or wrinkles,

transverse to the plane of dip, which increase in size, so as to resemble a delicate ripple mark, when the shale attains half an inch or so in thickness; when the beds have merely slid one on the other without curving, the interposed shale is striated in the direction of the dip; and thirdly, when great lateral pressure may have acted in conjunction with the sliding, the shale is highly polished. From the foregoing remarks, it must be inferred, that the limestones had attained a very considerable degree of hardness before they were subjected to those dislocating forces which have contorted them as we see, or before they could have produced such effects upon the softer material of the shale, as we have just described.

North-east of Killester Bridge the contorted beds of limestone and shale may be traced for the distance of about six hundred feet, appearing now and then through the thick coating of soil which now covers the slopes of the railway. Beyond this, they are not seen in this locality, the railway passing through a deep cutting of calcareous clay.

The course which the railway takes from Killester to Malahide may be described as a waved line, running N.E. as far as Raheny, when it gradually curves northwards, till it approaches close to the river Mayne, when its direction is from 10° to 15° west of north; the distance between Killester and Malahide is nearly six English miles by the railway, or five miles in a direct line, and this space is entirely occupied bya vast accumulation of drift consisting of gravelly calcareous clays.

About a mile from Malahide we again meet the impure calp limestones, which appear at the distance of nine hundred feet on the Dublin side of the New Road Bridge. The calp strata here consist of (in descending order)—

1st—Compact beds of earthy limestone, fifty to sixty feet in thickness, dipping S.W., at an angle of 20°.

2nd—Black earthy limestones, more slaty in character than those first met with, amounting in aggregate thickness probably to two hundred feet.

3rd—Hard black slaty shale, extending to the distance of about eight hundred and fifty feet, the thickness of which it would be difficult to determine, as this portion of the strata is traversed by many breaks, which displace the beds. Disseminated through this black shale are small fragments of Encrinite remains, and in the lower beds some shells.

The upper surface of the rocks which we have described, has been scraped and rounded, doubtless by the passage of the superincumbent gravel clay. This is well seen where the rocks first appear, cropping out from under this drift, on the Dublin side of the New Road Bridge, the furrows varying in direction from due east and west, to 70° west of north, and east of south. The same effect may be observed on all the old rock surfaces in this locality, the direction or

strike of the furrows being remarkably constant with those already stated.

Besides pebbles of the altered chalk, a rock at present characteristic of the N. E. of Ireland, this clay contains portions of flint, much rounded and of no great size. We may also observe in it fragments of various limestones, often fossiliferous—granite pebbles of the ordinary kind as well as sienitic. Conglomerate is rarely met with, but greenstones and fragments of the old quartzose and schistose rocks are not uncommon—an interesting group as taken in connexion with the prevailing direction of the furrows on the upper surfaces of the rocks, which underlie this gravelly clay.

After passing the New Road Bridge, the black slaty shale is terminated abruptly by a fault, and rests unconformably at an angle of 25° south, on the upturned beds of the lower carboniferous limestone. The lower portion of the shale has been broken into an angular breccia, and rests unconformably on the lower carboniferous limestone. From this point, to where the limestone disappears close to Malahide Railway-station, we have a thickness of beds, amounting to fully eight hundred feet, which consequently must be the minimum amount of displacement, which has brought together the carboniferous limestones and calp shales of this locality.

Besides an incipient cleavage, which Professor Oldham first noticed in these limestones, the central mass of beds exhibits fine examples of jointing. In many instances the joints have assumed the form of fissures, the surfaces having been corroded by the action of water filtering from above, which has worn away the softer layers, leaving the more hard to stand out in bold relief. Subsequently to this corrosive action the fissures have been filled with brown calcareous clay.

After passing Malahide, the railway is embanked across the Malahide estuary for the distance of more than a mile and half, when a second cutting is exposed, extending from Corballis road to the village of Donabate. Commencing at the southern end of this cutting, we meet the following rocks in ascending order:—

1st—About one hundred and eighty-two feet of the old red conglomerates, marls and grits, identical in composition, character, and mineral aspect with those which occur in the other districts of the island, where this system is more largely developed.

2nd—About one hundred feet of brown variegated shales, and calcareous earthy layers, full of nodules, and which contain some fossils, and which are again succeeded by a small mass of subcrystalline limestone—these beds, thus interposed between the normal old red, and the limestone, form the diminutive representative of that subdivision of the carboniferous system to which Mr. Griffith has applied the name of yellow sandstone. Nearer to Donabate we again meet the red grits and marls repeated, apparently brought into section by some break in the strata. Close to Donabate station

we find a cutting of seven hundred feet in length, through a mass of greenstone, which as we approach to Donabate, changes to a Felspathic Porphyry—the felspar crystals being of great size, and of a dull whitish green colour, imbedded in a purplish green, compact sub-crystalline paste. At the northern extremity of the cutting we again meet the old red quartzose conglomerate, not visible on the railway, but seen within a few yards of it—its dip here is also to the N.W.

Proceeding onwards from Donabate, the railway cuttings are through gravelly calcareous clays for the distance of nearly four miles. At Baldungan station, (now disused,) we find a patch of limestones and hard shales, about one hundred feet in thickness, dipping to the S.W., from 70° to 80°; the uppermost of these beds contain fragments of Encrinites. Beyond this, at the sixteen-mile post, we enter on the deepest cutting exposed by the railway, and have here a good section of the shales—limestones, grit beds and chert layers. When first seen, these rocks are traversed by many small breaks, which have much disturbed the beds, in many places causing the grit layers and black shales to abut against each other. Close to Loughshinny Bridge, there are massive grit beds, dipping S.W. at an angle of 50°; these are succeeded by black shales, and thin limestone layers, which, at forty feet N. of Loughshinny Bridge, are arched over in the distance of a few feet, and dip to the N. at an angle of 30°; beyond this, in the distance of about one hundred and twenty feet, there are three breaks in the strata, which a second time bring the grit layers into section; and these are succeeded by black slaty shale, and layers of limestone. Proceeding northwards, we again observe this rock, appearing at first nearly horizontal, but shortly dipping S.W., at an angle of 35°; beyond this, and included, in the distance of one hundred and forty feet, we have grits, black slaty shale, and limestone, and grit layers.

On the opposite side of the railway, commencing at Drumlattery Bridge, we have thin bedded limestones with shale, and some grit layers, for the distance of sixty feet, which dip S. at 65°, they are then curved over, and dip N. at 60°, which dip the limestones, shales, and grits retain for two hundred and sixty feet, when they disappear, and the cutting is through calcareous clay, which covers all the rocks we have noticed between this locality and Drumlattery Bridge.

At Skerries station the railway cuts through an escar for the distance of fourteen hundred feet, the section of which presents some interesting features indicative of sudden changes in the direction of those currents which deposited this sand and gravel; at the N. extremity of this escar, the coarse limestone gravel is overlaid by fine sand, delicately laminated and traversed in every direction by tubiform, and fibrous veins, of carbonate of lime, resembling somewhat in arrangment fibrous gypsum, when it occurs

in sandstone shale. This appears to be due to the percolation of water charged with carbonate of lime, which, in its passage through the sand, formed holes, and deposited the coating of the lime.

The calcareous clay overlying this sand and gravel, contains many sea shells, of the same species as those now living.

Within one mile of Balbriggan, we meet dark blue slates, which are occasionally concealed by calcareous clay. At Bellcamp lane, we have a good section of these slates; they are at first slightly micaceous, then silty, and of a light blue, passing to a light green, micaceous rock; then light grey, black and silty greenish, red and green; and lastly, green slates; average dip S. at an angle of 45°. We have beyond this, a cutting for about four hundred feet through greenstone, the scratches bearing E. and W., the greenstone joints S. 15° W. vertical. This rock is compact for the distance of about two hundred feet from Bellcamp Bridge. It then becomes vesicular, and at its junction with the slates is highly ferruginous. After passing Balbriggan, N. of Bremore-Road Bridge, we meet a section of successive masses of compact greenstone, and hard green felspathic slates in several alternations. The slates, though hard, do not appear to have been altered by contact with the greenstone, leading to the supposition, that they are both cotemporaneous; when freshly fractured and wet, these slates appear to have a finely granulated or oolitic structure. From this locality we do not see any rock, till within one thousand feet of the embankment over the river Delvin, (the boundary between the Co. of Dublin and Meath.) Here we have a small patch of earthy green slates, extending for 180°, but dipping S. 10° E., at an angle of 75°. In the centre of this mass, there are two small dykes of greenstone, about one foot six inches thick, which cut through the bedding, and slightly displace it. Over these slates there is a layer of sand and gravel, with a thin deposit of calcareous clay on top, containing fragments of recent sea shells. For the distance of two miles north of the river Delvin, the cuttings present nothing of any interest. At the twenty-six-mile post, a cutting of ten feet in depth, shows six inches of soil, one-sixth brown calcareous clay, containing qualities of recent sea shells, bones of fish, teeth and bones of animals; the rest of the cutting is through sand and gravel. Near the embankment over the Nanny Water, the cuttings, though but a few feet in depth, exhibit this pleistocene deposit best developed; here the fish bones are very numerous, and lying in position, each vertebra being in connexion with those to which it would naturally be attached. Northwards from this, for the distance of two miles and a half, the cuttings are inconsiderable, and through gravelly calcareous clays. Within eight hundred and twenty feet of Pilltown Bridge, we again meet the limestones and shales, dipping S.E. at an angle of from 15° to 20°; nearer the bridge, dipping N.W. at an angle of 75°; they thus continue for three hundred feet in places being vertical. At the Drogheda side of Pilltown Bridge, the lime-

stones and shales dip to the N.W. with great regularity, at an angle of from 5° to 20°; again appearing exposed by the low cuttings of the railway in three or four places between this and Drogheda.

January 14th, 1848—"On the section of the rocks at the Chair of Kildare," by Professor Oldham.

The Red Hills, Dunmurry Hill, the Chair of Kildare, Grange and Allen Hills, form an interrupted ridge, which has a general direction from north-east to south-west. The Red Hills and Dunmurry, are composed of a continuous series of numerous alternating beds of hard grit and slaty beds, for the most part of a greenish colour, with some brown slates. The grits are very hard, quartzose, and micaceous; the beds are highly cleaved; the cleavage well seen on the top of Dunmurry Hill. Below these gritty beds, which, as a whole-dip to the south-west or west-south-west at angles, varying from 35° to 60° we find a considerable thickness of red clayey slates, with one or two irregularly developed beds of limestone; to these succeed in descending order, some grey or greyish black slates, which form the lowest portion of the depression which divides the Hill of Dunmurry and the Chair of Kildare. The Chair itself is formed of thick irregularly developed bed sof compact and highly fossiliferous limestone, covered by thin beds of calcareous breccia, a mixture of volcanic ash debris with carbonate of lime. Intercalated with these beds of limestone, are beds of red slate, also fossiliferous. This interbedding is repeated several times, and lower in the series, we have beds of grey silty slates, with thin seams of limestone, and below, thin beds of trap breccias, with thin irregular layers of crystalline greenstone. Under all these is highly crystalline and very beautiful porphyry, with large crystals of whitish green felspar disseminated. The great mass of Grange Hill is composed of this rock, with crystalline greenstone frequently vesicular. Again, to the east of the Hill, we have several alternations of slates, ashbeds, and porphyry. Similar rocks form the Hill of Allen, to the east of which, at the leap of Allen, are hard beds of the old red conglomerate and thin beds of sandstone dipping at a low angle, towards the north-east. These also appear near Newington, in the flat ground which separates the Hills of Allen and Grange. Beds of the carboniferous limestone, also appear on the road side, beyond Dunmurry House, dipping to the south at a low angle. The whole range must have therefore been an old island of the silurian rocks, at the time of the deposits of the old red and mountain limestone beds.

From a consideration of the mineral character of the beds—from the perfect evidence of the beds having been disturbed and very much degraded—from the deposition of the old red conglomerate on them, so that a very long lapse of time must have occurred between the two periods—from the association of the trap rocks with them, in the peculiar way in which they occur, a mode of association only known in other districts to take place with the older silurian rocks, it was concluded, that the series of beds here exposed, belonged not to the upper silurian series, but the lower, and even to a part of the lower silurian series, very low down. The igneous rocks appear to be not protruded subsequently to the formation of the beds, but to have been of contemporaneous formation, no evidence of alteration existing, and all being affected by the same cleavage, which is well marked in parts of the range.

" Note respecting the probable geological age, and British equivalents of the silurian rocks of the Chair of Kildare, as inferred from the fossils they contain," by Professor E. Forbes.

During the course of the year 1847, extensive collections of fossils from the silurian limestone, and slates of the Chair of Kildare, have been brought together by the Members of the Geological Survey. An examination of these collections, and observations on the distribution of the organic remains in the locality itself, together with an examination of the collections made by Mr. Griffith, and described by Mr. M'Coy, in the synopsis of the silurian fossils of Ireland, have led to the following considerations respecting the age of the beds in question.

Hitherto geologists have been inclined to regard the isolated mass of silurian strata forming the Chair of Kildare, as probably either upper silurian, or as partly upper and partly lower, and the character of many of the fossils, such as the presence of (supposed) species of *Productus* in them, gave great probability to such a view. A closer investigation of the fossils, with the advantage of the recently made collection, leads, however, to the conclusion, that the beds are not only lower silurian, but members of the lowest part of the lower silurian series—that they are in all probability the equivalent of the Bala limestones, and the beds associated with them.

About eighty species of fossils have already been collected. Of three or four cephalopoda, none appear to be upper silurian, except *Orthoceras Ibex*, which, however, occurs in Wales, also in the Bala limestone. Out of nine or ten very beautiful Gasteropods, some of them very abundant, the majority are identical with Bala species; and some of these, which seem at first glance, more like upper silurian forms, as *Murchisonia bicincta*, M'Coy, and *Turbo tricinctus*, M'Coy, are most likely identical with Swedish and Russian lower silurian forms, *Turbo bicarinatus*, Hisinger, and *Trochus rupestris*, Eich-

wald. Two lamellibranchiate bivalves occur, the one *Avicula*, probably new, and the other the remarkable *Pleurorhyncus pristis*, Salter, hitherto only found in the silurians of Galway, where it is associated with *Pentamerus oblongus*. Of the numerous Brachiopoda, the majority are characteristic lower silurian species, and some of those hitherto enumerated, and characteristically upper silurian, have proved to be young or imperfect specimens of lower silurian species. Neither of the supposed *Producti* appears to belong to that genus; one of them is certainly an equirostral *Spirifer*, allied to S. Tcheffkini, and other Russian lower silurian forms. Two of the most remarkable brachiopods here are *Spirifer insularis*, Pander, (*Orthis galea*, M'Coy,) and the *Crania* called *antiquissima*, (but not that species) in the Synopsis. The former is a Russian lower silurian form, the latter occurs in the Bala series. A most abundant fossil is the *Spirifer lynx*, which (though it has a wide vertical range,) is when plentiful, characteristically lower silurian. Of the numerous trilobites, the most abundant is the *Illænus Bowmanni*, a Bala species. Many of the other forms are equally lower silurian in character, and among them are *Trinucleus caractaci* and *radiatus*, hitherto unrecorded from this locality. The crustacean so abundant in the Chair of Kildare limestone, recorded as "*Cythere phaseolus*," is not that species, (which is oolitic) but probably new. The corals are either lower silurian species, or species of great vertical range. Lastly, we have been so fortunate as to find in these beds three species of *Cystideæ*, all which occur in the lower silurian strata. *Caryocystites granatum*, and a new species of the same genus, are among these, both of which are Bala forms.

A comparison of these fossils with others collected in the limestone of Courtown, lead me to regard it as highly probable, that the beds are equivalents, and that both are the representatives in Ireland of the Bala limestones. If so, we thereby gain a geological horizon, which will enable us to draw an exact parallel between the Irish silurians, with those of Great Britain, and probably of northern Europe.

"On some Stalagmites from the Cave of Dunmore, County of Kilkenny," by Robert Mallet, Esq., Ph. D., President of the Society.

The author described the position and general character of the cave. It is formed beneath, and in beds of limestone, which above are interstratified with beds of Dolomite, through which the water, forming the stalactites and stalagmites, percolates. The fracture of some of these appearing not usual for carbonate of lime, they were submitted to a cursory chemical examination, which showed the existence of a sensible proportion of phosphoric acid, probably in

combination with lime. The author alluded to the extreme solubility of phosphate of lime by water, charged with carbonic acid, and supposed that the phosphoric acid was in this case, derived from washing out by water, thus charged with air and carbonic acid, from the magnesian limestone beds above.

He stated his opinion, that there were many circumstances tending to show, that the isolated masses of Dolomite in the carboniferous limestones of Ireland, were ancient coral reefs, and suggested the importance and value of enquiries directed to ascertain if any, or what relation subsists between the constituents in them and in recent corals.

In these stalagmites from Dunmore, layers of finely divided charcoal, are sometimes associated with the calcareous matter. These were found, on microscopical examination by Dr. Allman, to be the charcoal of coniferous wood, possibly the remains of ancient fires.

JOURNAL

OF THE

GEOLOGICAL SOCIETY OF DUBLIN.

VOL. III. PART IV. 1848. No. 3.

AT THE

ANNUAL GENERAL MEETING,

HELD ON

WEDNESDAY, FEBRUARY 9th, 1848,

ROBERT MALLET, ESQ. PRESIDENT, IN THE CHAIR,

The following Report from the Council was read :—

GENTLEMEN,

In resigning their trust into the hands of the Society, your Council rejoice that, notwithstanding the gloom which a national calamity has spread over every prospect, during the year which has just closed, they can congratulate the Society on its steady success.

The past year has been one marked with many causes tending to abstract from your meetings the presence of your most useful and valued members; but your Council can look back with pleasure to the success of your meetings; and from arrangements recently made under the sanction of the Society, they anticipate results of great practical and scientific value to the Society.

It becomes their duty briefly to state these arrangements, and the cause thereof. In August last, your Council received from the Board of Public Works an official communication, stating that the Board had received a letter from the Under Secretary of State for Ireland, requiring that the rooms then occupied by the Society, should be given up for the accommodation of the Poor Law Commissioners, the increase of whose department urgently demanded additional accommodation. On receipt of this letter, your Council immediately held a special meeting; and after mature consideration, adopted measures to bring the whole facts fully under the notice of his Excellency the Lord Lieutenant; but having ascertained that his

Excellency considered the matter as entirely under the control of the Lords of the Treasury, and having, by a second letter from the Lords of the Treasury, forwarded by the Board of Works in September, been required to give up their rooms immediately, measures were adopted for removing your collections.

Further communication was held with the Irish Government, in the hopes that accommodation of a similar kind to that formerly afforded to the Society, might be procured; but your Council were informed, that the great demand for offices, necessarily required for the public service, at a time when most of the public departments were increased in number, precluded the possibility of hoping that your Society could for some time be provided with rooms, equally well suited for their purposes, by the Government.

Since the re-assembling of the Society in November last, its meetings, as the members are aware, have been held in other apartments in the Custom House, the temporary use of which, for such purposes, was granted to them by the Board of Public Works; but your Council regret that they have been obliged to close your Museum from the public.

Under these circumstances, the future prospects of the Society engaged the anxious and repeated consideration of your Council; and after many and successive propositions, the Council, as the Society are already aware, submitted to a special meeting of the members, summoned for that purpose in December, the course which to them seemed most desirable to be adopted—a recommendation unanimously confirmed by the Society, the principal features of which consisted in transferring the geological and mineralogical collections of the Society to the University, to be incorporated with the collection belonging to that body, the Society obtaining the advantage of meeting-rooms within the University.

In proposing to the Society a connexion, under certain conditions, with the University of Dublin, your Council were mainly influenced by the high advantages which would result to the progress of geological science in Ireland, by inducing to more active exertion many of the influential inmates of the College, whose high scientific attainments would be brought to bear on questions affecting geology, thus advancing the primary objects of the Society, in the promotion of the study and knowledge of that science.

While, on the other hand, they felt that some acknowledgment, on the part of the Geological Society of Dublin, was due to the University, for the many efforts it has made, during the last few years, tending to elevate the study of natural science to its proper position. Your Council also have been much impressed with the great advantages which must result—especially in a city where the support of such bodies is necessarily limited—from uniting the resources of several, devoted in a great degree to a similar result. Thus they felt, that for the geological students, the Museum arising from an union

of that of your Society, with the collection already possessed by the University, must be of infinitely greater service and utility, than either could be, had they remained separate; and further, that the Society being relieved from the expense and trouble, consequent on maintaining their Museum, would be enabled to devote their undivided energy to the increase of their Library, and collections of maps, charts, &c.

Your Council, therefore, cannot but congratulate the Society on the prospects which now open to them of the increased value and utility of the Society, of the higher scientific character of its transactions, and of the important practical influence which it is likely to exert. And they would also express their warm and grateful sense of the very friendly and anxious manner in which the propositions have been seconded by the heads of the University.

Your Council regret that they have been deprived of the services of your late Assistant Secretary, Mr. Du Bourdieu, in consequence of his deserved appointment to another office; but they desire to record their high estimate of the zeal and attention with which, while engaged in your service, he devoted himself to his duties.

During the past year the following members have been added to your Society:—

Samuel Downing, Esq. C.E. Assistant Professor of Civil Engineering, T.C.D.
F. W. Burton, Esq. M.R.I.A.
Thomas Antisell, Esq. M.D.
Rev. C. Graves, F.T.C.D.
Rev. S. Haughton, F.T.C.D.
W. H. Harvey, Esq. M.D.

Your Treasurer's Accounts are annexed, by which it appears that there is a balance to the credit of the Society of £39. 6s. 9½d.

Abstract of Accounts of the Geological Society, for the year ending February, 1848.

Cr.	£.	s.	d.	Dr.	£.	s.	d.
To Balance in Treasurer's hands per last year's Account,	35	1	2½	By Printing, Stationery, Advertising,	33	3	2
— Admission Fees,	3	0	0	— Assistant Secretary, Twelve Months,	30	0	0
— Annual Subscriptions,	83	0	0	— Repairs, &c.	0	8	6
				— Porter, and Messenger,	12	0	0
				— Postage, Lighting, Coals, Carriage of Parcels, &c. &c.	6	2	9
				— Balance in Treasurer's hands,	39	6	9½
	£121	1	2½		£121	1	2½

I have examined the above abstract, and the Vouchers relating thereto, and find it correct.

Dublin, 9th February, 1848.

ROBERT CALLWELL.
Auditor.

List of Donations received since last Anniversary Meeting.

TO THE MUSEUM.

Skull of short horned Ox, and some other bones, from the King's Bridge Terminus of the Great Southern and Western Railway, from Robert Mallet, Esq.

Specimen of native Carbonate of Manganese, from the County of Clare, from Sir Robert Kane, M.D.

Specimen of Shaley Limestone, from the County of Limerick, showing curious markings, from Robert Mallet, Esq.

Two specimens of Potter's Clay, from Dungannon, County Tyrone, from Robert Forster, Esq.

Two Specimens of Copper ore, from the Kapunda Mines, South Australia, the property of Captain Bagot, from F. W. Burton, Esq.

Specimens of Calp Limestone, from near Trim, exhibiting remarkable concretionary forms, and

Some Fossils, from J. Searancke, Esq. County Surveyor, Meath.

A fine series of Fossil remains, from the Himalaya Mountains, including portions of Elephants, Hippopotamus, &c. from William Beatty, Esq., M.D.

Stalagmites from the Cave of Dunmore, from Robert Mallet, Esq.

TO THE LIBRARY.

First six volumes of The Encyclopedia Britannica, seventh edition, and Killarney Revisited, from Owen Blaney Cole, Esq.

On the Microscopic Animals in the rocks of Yorkshire, by John Phillips, Esq., F.R.S., F.G.S., &c. from the author.

On the Volcanoes of the Moon, by James D. Dana, from the author.

The Antient World, or Picturesque Sketches of Creation, by D. T. Ansted, F.R.S., Professor of Geology in King's College, London, from the author.

Volumes 1 and 2, and No. 9, of The Quarterly Journal of the Geological Society of London, from the Society.

No 10 of The Quarterly Journal of the Geological Society of London, from the Society.

The Report of the British Association for the advancement of Science, for 1847, from the Association.

First volume of the Gesellschafte der Freunde der Naturwissenschaften Austria, from the Society.
Uber die cephalopoden du Austria, by Haidinger, from the author.
Proceedings of the Zoological Society of London, from the Society.
Nos. 11 and 12 of The Quarterly Journal of the Geological Society of London, from the Society.
First and Second Reports of the Progress of the Dublin University Museum, from R. Ball, Esq., Director.
The Mining Journal, for 1847, from the Editor.

A ballot having taken place for the election of Officers for the ensuing year, and scrutineers appointed, the following were declared duly elected:—

President.

PROFESSOR OLDHAM.

Vice-Presidents.

RICHARD GRIFFITH, ESQ.
SIR H. DE LA BECHE,
JAMES APJOHN, ESQ.
ROBERT MALLET, ESQ.
REV. H. LLOYD, D.D. S.F.T.C.D.

Treasurers.

WILLIAM EDINGTON ESQ.
WILLIAM MURRAY, ESQ.

Secretaries.

ROBERT BALL, ESQ,
SAMUEL DOWNING, ESQ.

Council.

C. W. HAMILTON, ESQ.
JOHN MACDONNELL, ESQ.
THOMAS HUTTON, ESQ.
GEORGE WILKINSON, ESQ.
ROBERT CALLWELL, ESQ.
WILLIAM ANDREWS, ESQ.
SIR ROBERT KANE, M.D.
PROFESSOR ALLMAN,
GEORGE V. DU NOYER, ESQ.
JOHN D'ARCY, ESQ.
CAPTAIN LARCOM, R.E.
F. W. BURTON, ESQ.
R. CARMICHAEL, ESQ.
REV. C. GRAVES, F.T.C.D.
REV. S. HAUGHTON, F.T.C.D.

The President then read the ANNUAL ADDRESS. After the address had been concluded, the following Resolutions were unanimously passed:—

"That the cordial thanks of the Society be presented to the President, for his constant exertion in the cause of the Society during the past year."

"That the warmest thanks of the Society be presented to the several Officers of the Society, for their zealous attention and endeavours to promote the objects of the Society during the past year."

The Society then adjourned.

ADDRESS.

The completion of another geological year to our Society makes it again, and for the last time, my duty to address you, to review our own progress, and that of the science we cultivate, during the twelve months past.

The first paper that came before us at our general meeting in March last was a notice by Sir Robert Kane, of the occurrence of carbonate of manganese in the county of Clare, accompanied by analyses of the mineral substance, which occurs as a yellowish grey thin earthy bed, underlying about two feet of bog, and reposing upon decomposed old red sandstone. It contains from about seventy-five to eighty per cent. of manganese in the state of carbonate. Manganese occurs very rarely in the state of carbonate, and has probably not been before observed in the same state of aggregation. The author considers it as a distinct mineral species, and new to Ireland. He notices the difficulty with which this carbonate parts with its carbonic acid in certain conditions, but does not propose any theoretic view as to the formation of the mineral in situ. It seems to me not unlikely that it may have altogether resulted from the slow and long-continued action of the decomposing bog, (which is constantly evolving carbonic acid) upon the oxides or salts of manganese contained in the equally decomposing rock below. Two analyses of calcareous marls from the same locality are also incidentally given.

Carbonates of manganese in other forms of aggregation and combination are not uncommon, and analyses of many have been given. Kersten, in the *Jour. fur Prac. Chimie*, gives one containing eighty-one per cent. of manganese and combined with carbonates of lime, magnesia, and iron. Breithaupt has described a similar substance; and Rammelsberg, in *Poggendorf's Annalen*, has lately given the analysis of another, which appears to be a true simple mineral, and of fibrous structure.

Doctor Kane's analyses are not discussed with reference to their reduction to a formula, nor in this case would it probably have resulted in the indication of these manganesiferous substances being simple minerals, but rather mixtures of uncertain composition.

Our next paper was by Professor Oldham, who exhibited the results of the fusion of some igneous and trappean rocks from the county of Wicklow. Four specimens of various rocks had been operated on by heating in Cornish crucibles, in a wind furnace, for periods of from one to two hours; a talcose slate of a steatitic character, a sienitic greenstone, and a compact felspar—all produced vesicular glasses, with interspersed particles unfused; but a crystalline diallagic greenstone, with mica, proved refractory, and became recompacted from the powder, into which all the specimens had been previously reduced.

Experiments of this class may be of the greatest value to physical geology; but although a great many have been made at various times, the want of due attention to all the conditions demanded, and the great difficulty of fulfilling some of these, have deprived the results, so far, of any very general importance.

All such pyrognostic researches divide themselves naturally into two sections—those in which we take account by careful analysis of the chemical and mineralogical properties of baked or fused bodies, produced in manufacturing processes on the great scale—such have been the researches of Berthier on the composition of various slags; and later, of our countryman, Doctor Percy, and the recent valuable analyses of the copper slags and other products of the copper works of Reichelsdorf, by Genth, published in the *Journal fur Prac. Chim.* The range of this class of experiments is necessarily limited by the conditions of the manufacturing processes, of which the educts are examined; but the large scale upon which these operations are conducted gives results of greater uniformity, and enables the conditions of consecutive experiments to be more perfectly identical than is possible in the laboratory. The matter not to be neglected here, is well to take account of what all these prior conditions are, and in this respect Genth's memoirs may be taken as a model.

The other class of these experiments is, that to which Professor Oldham's belong, and of which the late Mr. Gregory Watt may be considered as the originator.

It becomes here a preliminary question—whether accurate and characteristic results may best be had by operations conducted upon a comparatively very small scale, and with refined and delicate apparatus, such as Faraday adopted in his beautiful experiments upon his heavy glass for optical purposes, and with precaution that no reaction shall occur between the substances and the apparatus employed for fusion; or whether by operating upon large masses with furnaces upon a great scale, the errors introduced by such reactions may not be eliminated, or at least caused to vanish in the strongly impressed character of the results.

To the physicien and mineralogist alone I am disposed to believe the former course will be most useful, as the recent investigations

of Ebelmen and others seem to indicate; but to the geologist, I believe that pyrognostic experiments, conducted upon a very great scale, will alone be of much value, and such might I believe, be made of importance commensurate with their cost. Gregory Watt's few experiments were alike beautiful and valuable in his day; but our subsequent progress now demands regard to other conditions not attended to then. We now possess more trustworthy pyrometric instruments, which must be used; and although even yet we cannot rigidly determine relations of very high temperature, we may use test or standard minerals, whose physical and geological relations to heat are best known in conjunction with the objects we experiment upon, and thus obtain pyrometers of the most immediate value to the physical geologist.

The molecular conditions of bodies operated on by heat demand close attention; and for this the appliances of physical optics may frequently be called into use, an instance of which we have in our member Dr. Apjohn's researches upon the Hyalites. Still more important is it that the specific gravities of bodies thus operated on should be carefully recorded. In my address of last year I noticed the valuable researches of Deville on the difference in density of rocks before and after fusion; and I am now enabled to remark upon some still more remarkable facts of the same class recently elicited by Gustav Rosé.

Alexander Brogniart, in his Traite des Arts Ceramiques, long ago remarked that porcelain that had merely been baked hard *(degourdie)* was denser than that which had been completely fired; and yet we all know that porcelain, like every other aluminous material, contracts by heat.

Rosé has pushed this inquiry further than his predecessors; and in *Poggeudorf's Annalen* has given the analyses of all the materials of his experiments, and the changes of density suffered by porcelain from the first approach to hardness up to that perfect baking that verges upon fusion. He finds, to take one example, that porcelain that has a density of 2.643 when first hardened in the fire, has its specific gravity reduced at the point of incipient fusion to 2.345. In some degree we may account for this from the decrease in density which feldspar suffers in passing from the crystalline to the glacial states by fusion. Rosé finds this to be in the ratio of 2.5756 to 2.3870, in one case.

Results which connect themselves with these were long since known with respect to Reaumur's porcelain, in which the converse molecular change takes place of the glassy structure by long baking assuming that of sub-crystalline porcelain. It is needless to point out to the philosophic geologist the wide-spread bearing and importance of these minute molecular changes to the great changes of state in formations with which he is occupied.

In April, Doctor Apjohn communicated a paper of remarkable

interest upon an undescribed variety of Hyalite from Mexico. The mineral occurs in large, glassy, transparent, globular concretions, and while it presents all the usual external characters of the ordinary hyalites was found to differ wholly from them in chemical constitution, and in fact to form a new mineral species, or hydrate of silica, expressed by the formula.

$$15.SiO_3 + 2\ HO.$$

and containing little more than two and a half per cent. of water, while the described specimens contain from five to ten per cent. But the most remarkable properties of this new mineral are those which Dr. Apjohn has developed, by the refined researches of physical optics; by which he has been enabled to conclude that the concretion or tear of Hyalite is, in fact, a confused aggregation of microscopically small crystals of rock crystal, massed together in all possible directions. It would be out of place here to pursue the optical views of this subject which the author suggests. The paper affords a favourable instance of the mutual aid and affinity of distant sciences, in showing how the invisible molecular arrangements of a colourless and transparent mass have been made evident, or, as it were, anatomised by the skill of the physical optician, and brought to bear upon mineralogy and geology. Additional interest has been given to this paper of Dr. Apjohn's, by the publication of M. Ebelmen's highly important and curious researches on the artificial formation of certain other hydrates of Silica. He has succeeded by slowly evaporating Silicic ether, in forming large and solid cakes of hydrophane or *tabasheer*, possessing all the optical and physical properties of that found naturally secreted by the Bamboo, opaque, when dry, and becoming instantly transparent when dipped into water; and further, in even so combining the Silica with salts of the noble or easily reduced metals, as to diffuse these in scales of great brilliancy through the mass, thus producing an artificial Avanturine. He finds these masses continue in molecular movement progressively contracting for many months. The geological importance that attaches to these investigations arises from the light they throw upon the general question of the gradual formation, consolidation, and induration of minerals, produced in conditions of aqueous or fluid action.

On the same evening, Professor Oldham also exhibited some sheets of the Geological Survey of Ireland. These were sheets of sections, and were brought before us as an earnest of the several valuable communications emanating from this survey, and some of which have been subsequently brought to this Society.

Professor Allman read in May a notice of erratic blocks of greenstone occurring in the neighbourhood of Bandon, Co. Cork. These are found lying on the carboniferous slate, which is the principal rock of the district, and are scattered over an extensive area.

Their chief locality, however, is in a small valley, which runs nearly east and west, about two miles to the north of the town of Bandon. They occur here in very large rolled masses, some of the blocks weighing several tons. The author doubts that greenstone is found anywhere in the neighbourhood presenting characters identical with those of these boulders, which the author considered as syenitic. On the subsequent discussion, however, there appeared some doubt of this, owing to the general confusion prevailing amongst lithologists as to the precise characters which constitute the title to syenitic. Two prevailing circumstances characterise the boulders of Ireland, in common with some other countries. Surrounding the margins of any great geological district or area, we find great numbers of boulders, of various sizes, consisting of the closely adjacent rocks, from which the masses forming this areola have been but for a short distance removed; besides this, we find much more rarely scattered blocks removed to vast distances from their origins, or from the rocky masses with which they can be identified. Any contributions to the history and conditions of these latter are facts of great value and importance to geology.

The next paper was one by myself, in which I have endeavoured to show, that transport to vast distances of boulders or erratic blocks of almost any conceivable magnitude, may be accounted for by the slow or occasionally rapid movement of semifluid masses of mud, gravel, sand, &c., mixed with those larger materials, when forming the bed of the sea, and either of sufficient depth and mass alone, or resting upon a base of rock, or other materials of very moderate slope, combined with the sorting and transporting power of the tidal currents for the finer materials of the whole mass. That, in fact, the vast accumulations of mud and sand, &c., involving all sorts of heterogeneous materials, which constitute the great mass of the sea bottom, must, around the shores at any given time, be in constant motion outwards, forming, what I have elsewhere called *mud glaciers*—a somewhat anomalous but expressive term—that these masses reduced in water to nearly one-third of their weight, will move gradually on slopes of three or four degrees, or even less, and that when the length of plane is as enormous as it in many instances appears to be in the ocean bed, when fresh materials are constantly added to the finer mass by tidal estuary deposits, and fresh blocks supplied by the fall of rocky masses from shore cliffs, and when the outer edge or talus of such banks, going into deeper water, is continually sorted and removed by tidal or oceanic currents crossing the line of slippage, or motion of the mass, transport of the contained blocks may be accounted for to vast distances, and taking in the element of successive elevation of land, and hence of new shores, being pushed further and further out, that this machinery alone is sufficient to account for transport of blocks to an indefinite distance. I also remark, that the cases of

furrowing, grooving, and scratching of rocky surfaces, now beginning to be so generally remarked, originate in most instances from the action of hard and isolated masses of rock, or pebbles, held fast in the under part of the moving mass of the mud glacier (so to say) like emery in the lapidary's wheel, and pushed slowly, but with irresistible force, in one direction, over the rock on which the whole slides, or rather flows. In a word, so far as the traces of past abrasive action upon its rocky bed are concerned, I believe that there is not one phenomenon observed or producible by the ice of a glacier that is not equally to be found produced upon the rocky skeleton of the now dry land, and also beneath the sea, by the slipping, or rather by the semi-fluid flowing of these vast masses of mud and gravel, with included rock; and I cannot avoid quoting the last sentence from a recent memoir of M. Du Rocher, on the glaciers of the north and centre of Europe, in which this able geologist has unconsciously given the strongest support of this view:—

"Quant a la resemblance des erosions glacieriques, avec celles des phenomenes erratiques pour montre que des causes, de natures differentes pouvent produire des effects mechaniques analogues, il me suffiira d'ajouter que jai observe, en diverse contrees, et sur des roches diverses, mais principalement en Bretagne et sur du quartsite, de belles surfaces polies et striees, qui ont ete produits par le glissement des rochers les unes sur les autres, et qui cependant ressemblent beaucoup, aux surfaces erodees par les glaciers, ou par les agents erratiques." *Comptes Rendu*, 15*eme Mars*, 1847.

And in this view I venture to predict, that future investigations will show that the whole rocky skeleton of our earth, both land and water, wherever covered with loose material, is scratched over in directions as various as those in which the mud slidings took place, of which these scratches are the traces. I shall not advert now further to this subject, but may make a few additional remarks upon it when referring to recent labours of other geologists in this department.

In June we had an interesting paper from Professor Oldham upon pseudomorphous crystals of mica. Andalusite occurs in great abundance in the slates of the county of Wicklow. It is found irregularly deposited between the lamina—most abundant when the slates are most argillaceous, and usually of a brownish grey colour. Mr. Weaver, as noticed by Professor Oldham, had some years since remarked, that occasionally "the character of this andalusite is altered by a more or less intimate incorporation of mica;" but Professor Oldham seems first to have carefully observed and recorded the facts of the complete replacement of the one mineral by the other, and also of the conditions of partial replacement. The planes of the mica crystals usually run across the principal axis of the original crystal of andalusite, but sometimes intrude in planes perpendicular to every surface of the crystal. Mr. Oldham

connects this phenomenon with the facts of metamorphism, which he has studied in the neighbourhood of Lough Nahanaghan and Cadeen mountain; and observes, that metamorphic action in this district appears always attended with a greater or less transfer of elements in the neighbouring rocks.

On the same night I brought before the Society some views as to the circumstances under which the quartz rock and slate formations of Wicklow have been arranged, together with some remarks upon a peculiarity of lamination in the finer grained and micaceous slates. The general view advocated was, that the slates, whether coarse grained and gritty, as they are found in many parts of Wicklow to such a degree as to appear rather granular quartz, or when fine grained, magnesian, and shining, as well as the quartz rock, which is found of all degrees of fineness, and embedding rounded pebbles of various size, have formed parts of one great and contemporaneous physical formation, which took place either at the mouth of a vast estuary, or in a tidal sea of the ancient ocean. That the separation into clean washed gravel and sand, with imbedded pebbles, which now form the varieties of quartz rock, and into sandy mud or slimy mud, which now form the gritty and the micaceous slates, were all due to the sorting and transporting operations of water in motion, and acting upon heterogeneous materials derived from the debris of still more ancient rocks. I illustrated these views by showing that precisely analogous phenomena, though upon a much smaller scale, and not accompanied by the induration of the deposits, nor upheaval of the bottom, are now taking place in the upper lake of Glendalough, county of Wicklow. That here the debris of the granite and slates in the mountains above is regularly sorted by the conjoined action of the currents of the lake, and the prevailing winds acting on it, into deposits which, if compressed, baked, and indurated, would present all the characters of quartz rocks, and slate of various sorts.

I showed that while some of these deposits were taking place in comparatively deep water, others were forming in water extremely shallow—that few organic remains of existing animals were being entombed in the former, the beds of which were level, smooth, and unruffled, while numerous fresh water shells, and other organised beings were being buried in shallow water deposits close to the shores of the lake, and that here the beds were all characterised by ripple mark—and from these examples I deduce that the beds of the silurian, or other lower slaty rocks in this district and elsewhere, which other circumstances induce us to believe were deposited in the water of a deep sea may have been so, and yet be found now characterised by ripple mark here and there, (as in Cork, Kerry, Clare, Carlow, &c.,) produced upon their induration, along shores successively elevated, and to the shallow water of which ripple mark must, except in case of rapid streams, be confined.

The peculiarty of lamination in the more micaceous slates alluded to, consists in a remarkable wrinkling occasionally of the surfaces of laminæ, bearing some resemblance to small ripple mark, but yet obviously not such. This peculiarity was remarked by Professor Oldham to me, at about the same period that it engaged my own attention. The explanation I was disposed to adopt, refers this wrinkling to the same semi-fluid motion in great masses of slowly deposited mud or slob, which I have adverted to as a cause of boulder transport, by which differential movements of the thin successively deposited beds of mud would be produced, and such wrinkling in particular directions as we now find on this mud become slate—motions, in fact, analogous to the "banded structure" of Professor James Forbes.

At our first meeting in November, Mr. Du Noyer read the first part of his paper on the geological sections exposed by the cuttings on the line of the Dublin and Drogheda Railway, being a portion of his labours as connected with the geological survey of Ireland. This paper is a vast and careful collection of facts, recorded with that minuteness of detail which becomes the important public department to which it appertains, and with a clearness of argument that marks the scientific geologist. It was illustrated by the clear and spirited sectional drawings of Mr. Du Noyer. The author notices the scratched and furrowed rocks first observed on this line by myself some years since, and of which some large specimens exist in our collections, and attributes them to the passage of masses of detrital matter over the rock. The occurence of recent sea shells in the clay banks, and of pebbles of rocks from distant origins, the removal of limestone by infiltration from the planes of jointings, and very many other valuable facts, are recorded; but from the very opulence of the paper in detail it scarcely admits of that notice in abstract which the labour of the author merits. The wrinkling of the strata of the shaley beds is noticed and attributed by Mr. Du Noyer to compression of the lamina when not perfectly indurated.

The next paper was by Professor Oldham, and was one of the most interesting in its subject that has for a length of time engaged our attention. In this he records the first clear, perfect, and undoubted evidence obtained of the former existence of the rein deer in the British islands. The antlers and other remains of the Cervus tarandus, since identified with those of the Caribou, were found near Kiltiernan, county of Dublin, embedded in marl and clay, in company with great numbers of antlers of the Cervus megaceros, all occupying but a very limited space. One extremely doubtful, and another mutilated specimen of rein deer, presumed to be Irish, had previously been under the notice of our Secretary, Mr. Ball: and Professor Owen, in his Report on British Fossil Mammalia, was only enabled to rest his evidence of the

former existence of these animals in Great Britain, upon two much broken specimens.

We have here, then, the evidence perfected of a most important fact in Palæontology—one which adds greatly to the pre-existing arguments in favour of our islands being but the remains, and probably the last remains, and those having been partially, if not wholly submerged and again elevated, of that vast Atlantic continent of a former world, which the researches of Professor Edward Forbes have recently brought so forcibly before geologists.

The last paper of this evening was a notice by Mr. Du Noyer, of a black substance, externally resembling bitumen, from Cappa bog in the county Kildare. I am disposed to consider this substance as most probably Humine, or the Geine of Berzelius, or at least belonging to that class, but have not been able to examine the specimen myself. Mr. Du Noyer remarks the extremely friable and decomposed condition of the limestone pebbles, and those of green stone, beneath this bog, most of the calcareous matter of the former being removed, and merely a soft mass of clay or mud left. In the discussion which followed it was suggested that this change was possibly due to the Tannic acid of the bog. I am rather inclined to attribute the reaction to the same cause to which I have already alluded, in noticing Sir R. Kane's paper on carbonate of manganese, occurring in a similar position. I believe that the carbonic acid, continually evolved from the wet peat, was, together with the action of water charged with the same, the agent which removed the lime in the state of bicarbonate, and acted on the magnesian bases of the greenstone pebbles in a similar way

Our December meeting was occupied with the continuation and conclusion of Mr. Du Noyer's elaborate paper on the Drogheda Railway cuttings, illustrated by his sections and drawings.

In January we had a valuable communication from Professor Edward Forbes, respecting the probable geological age, and British equivalents of the silurian rocks of the Chair of Kildare, as inferred from the fossils they contain.

During the course of the year 1847 extensive collections of fossils from the silurian limestone and shales of the Chair of Kildare have been brought together by the members of the Geological Survey in Ireland. An examination of these collections, and observations on the distribution of the organic remains in the locality itself, together with an examination of the collections made by Mr. Griffith, and described by Mr. M'Coy, in the synopsis of the silurian fossils of Ireland, have led to the following considerations respecting the age of the beds in question.

Hitherto geologists have been inclined to regard the isolated mass of silurian strata, forming the Chair of Kildare, as probably either upper silurian, or as partly upper and partly lower, and the charac-

ter of many of the fossils, such as the presence of supposed species of Productas in them, gave great probability to such a view.

A close investigation of the fossils, with the advantage of the recently made collection, leads Professor Forbes, however, to the conclusion, that the beds are not only lower silurian, but members of the lowest part of the lower silurian series—that they are in all probability the equivalents of the Bala limestones, and their associated beds. About eighty species of fossils have been already collected and examined.

These the author described and discussed in detail. They include a few new species. The great majority of these forms are identified with lower silurian, Bala, or Russian species. Two lamellibranchiate bivalves occur. The one an Avicula, probably new, and the other the remarkable Pleurorhynchus pristis, hitherto only found in the silurians of Galway.

Of the brachiopods, some forms hitherto supposed to characterise upper silurian beds, have proved to be young or imperfect specimens of lower silurian species. A new crustacean is provisionally recorded, and three species of cystideæ (those simple and remarkable forms which, chiefly by the labours of Von Buch, have been shown to be the earliest created of the great family of crinoids,) all such as occur in the lower silurian strata. Caryocystis granatum, and a new species of the same genus, are among these, both of which are Bala forms.

A comparison of these fossils with others collected in the limestone of Courtown, county Wexford, leads the author to regard it as highly probable that the beds are equivalents, and that both are the representatives in Ireland of the Bala limestones. If so, Professor Forbes proceeds, "we thereby gain a geological horizon which will enable us to draw an exact parallel between the Irish silurians and those of Great Britain, and probably of northern Europe."

Professor Oldham, on the same evening, exhibited a large section of the rocks forming the Chair of Kildare, which showed clearly the interposed beds of trappean rocks. The intercalated character of these rocks, which do not seem to be protruded subsequently, as might at first sight be presumed, but regularly interstratified, and having, the author states, a cleavage of a well marked character common to the silurian beds in which they lie, seem so similar to the general characters of the beds of igneous origin in the great lower silurians of Great Britian, as to leave no doubt as to the horizon of these rocks, being of the lowest beds of the lower silurian, when viewed together with the palœontological evidence of Professor Forbes's paper. These two papers together, are of much importance at present, when the original creator of the silurian system finds it necessary to defend his territory, won certainly with much labour, skill and zeal, from the invasion of the Cambrian from below, and the Devonian from above.

Apart from that feeling which Sir Roderick Murchison may most justly entertain, the wish to preserve unharmed the title of formation which must ever be associated with his geological labours in the Palæozoic rocks, every geologist must regret that the Cambrian system had a title to separate existence conferred upon it before that existence was fixed upon the only true basis, that of the identification of strata by their contained fossils; and that the risk of future confusion in nomenclature at the very least, is now incurred by the intrusion of the upper part of the assumed separate Cambrian system upon the lower silurian rocks.

The Silurian system has now been extended and identified over great and distant areas, and how far it will be found hereafter to absorb the whole of the Cambrian, further and future researches, like those just noticed, and the careful fixation of horizons upon Palæontological bases in many and distant places can alone establish.

Unless a distinctive zoological type shall be hereafter pointed out, by which the rocks of North Wales, of Westmoreland and of Cumberland, shall become entitled to exist as a separate system, and which it is quite possible the future researches of Professor Sedgwick, who has so ably described their physical and local characters, molecular structure, dislocations, and in part, their fossils, may still point out, the title of Cambrian system must hereafter, I conceive, be either disused or used in a new sense, as applied only to the very old and unconformable 'greywacke' underlying the whole of the beds, which are identifiable with the silurians by their fossils,

The last paper of our year was a short notice, presented by myself, along with specimens of stalagmite, from the cave of Dunmore, county of Kilkenny. This cave is one of those vast excavations so common in all great limestone districts. The limestone beds directly above it are interstratified with beds of Dolomite, through which the water, charged with calcareous matter, descends, to form the great masses of stalactite and stalagmite that in some places have filled up the cavern.

The fracture of these concretions appeared to me not usual for carbonate of lime in this form, and on a cursory chemical examination I was able to satisfy myself that the stalactites contain a sensible proportion of phosphoric acid, probably in combination with lime.

The researches of Dumas have recently shown the extreme solubility of phosphate of lime in water charged with carbonic acid; such, that bone or ivory shavings, are softened in a few hours, when immersed in a bottle of Seltzer water, and most of the phosphates removed. The phosphoric acid seems to be here derived from washing out by water, thus charged with air and carbonic acid, from the magnesian limestone beds above.

Many circumstances induce me to suppose that the isolated and scattered masses of Dolomite occurring in the carboniferous limestones, are the fossilization of ancient coral reefs. It becomes a

question of great interest, therefore, to determine rightly the proportion of phosphates present in unwashed and unweathered specimens of those dolomites, and, if possible, to discover whether any, and what relation subsists between these constituents in them and in recent corals. The latter part of the inquiry has already, to a certain extent, been made by Mr. Silliman, jun., whose analyses of thirty-five specimens of recent corals were published in Dana's report on Zoophytes, as part of the results of the United States' exploring expedition of 1838 to 1842. This inquiry also connects itself with the nearly constant presence in the mineral kingdom of fluorine wherever phosphorus occurs, as determined by Gustav Rosé in seven varieties of apatite—noticed by Dr. Daubeny in the phosphorite of Estramadura—by Dr. Rees, Lassaigne and others previously in fossil bones, into which the fluorine seems to be merely introduced through the agency of water and carbonic acid, as very little can be detected in recent bone—and by Mr. Middleton and Dr. Graham, in the water supplying London, in the sediment produced by boiling which they detected it. Graham states, that confervæ grow in the waters supplying London with great rapidity, and suggests that the fertilizing properties of some waters, celebrated for irrigation of meadows, may be owing to this presence of phosphoric acid; a thought of great practical importance, and which again suggests the desirableness of the public possessing official information as to the chemical constitution of all the principal fresh waters of our islands that are applicable to irrigation, as one branch of the geological survey. This desideratum is capable of being fulfilled as respects phosphoric acid, and the few other influential constituents, at a very small expenditure of time and public money, and is probably of quite as much importance as the analyses of soils or metalliferous materials.

In these stalagmites from Dunmore, layers of finely divided charcoal are occasionally interlaminated with the calcareous matter. On microscopic examination, Dr. Allman finds this to be the charcoal of coniferous wood; probably the remains of very ancient fires that were once kindled upon the floor of the cavern, and thus affording some rude measure of the time occupied in the accumulation of the stalagmite above them.

This completes the review of our labours for the past year, one which shows that the communications made to the Society have not diminished in value or interest; and that notwithstanding the difficulties which have peculiarly affected us, in having been deprived of our apartments in the Custom-house, we still continue to advance our science.

Looking now from our own immediate labours to those of other British and foreign geologists, I purpose to make a few observations upon some of the points of recent geological importance and advance ment, not pretending, however, to give anything like a complete or

systematic view of the recent progress of geology, for which neither your time nor patience would here suffice, even if my own avocations, and the lamentable absence from all our libraries in this country of recent and indispensable geological literature, did not render such an attempt here impracticable. I shall divide my observations into distinctive heads, without, however, particular care as to system, and beginning with the surface first, allude to the later inquiries upon ice.

Of late years perhaps no branch of physical geology has excited such great and general interest as that which concerns the formation, motion, and functions of ice, past and present, by sea and on land. The formation and supply of glacier ice, the mechanics and conditions of movement of glacier masses, their probably vastly greater extension at former periods, and the presumed occurrence of a so-called glacial period, have formed one great class of these inquiries, while another of equal interest has been the consideration of the transporting or carrying power of glaciers for rocks and mineral masses, foreign to themselves, and of detached and floating icebergs, bearing similar freights. It is now so long ago as the year 1815 since Charpentier first began his investigations as to the existence of a former greater glacial development than now. Venetz was soon after led into a similar train of thought, and in 1834 the doctrine of an ice period was first clearly broached, at the meeting of Swiss naturalists in Lucerne. Charpentier's views, however, were in advance of his hearers, and indeed of the geologists of Europe, so much so, that they met with little attention—quite as little as the views which I myself about the year 1837 promulgated in these countries as to glacier motion—views which, incomplete and in part erroneous as they were, may I believe, be said to have first awakened geologists in Great Britain, to the importance of the subject, which the researches of Agassiz soon after following confirmed. It is impossible within my limits to attempt even a perfect sketch of the progress of geology in this direction. It may be useful, however to give a list of the authors who have treated most importantly upon it—amongst these are Agassiz, Desor, Guyot, James Forbes, Studer, Escher de Linth and Blanchet, besides those whose early works I have already noticed, all on the Alps; Leblanc, Renoir, Hogard and Collomb, on the Vosges; Agassis, Lyell, Buckland, Smith, Maclaren, Mylne, Oldham, and many others in Scotland, England, and Ireland; Adolphe Brogniart, Sefstroem, Keilhau, Boethling, Siljestroem, Daubrée, Murchison, Verneuil and Durocher, in Scandinavia; Hitchcock, Darwin,and Lyell, in America; and Strachan in India.

The latest publications of Professor James Forbes, commencing from his 12th and 13th letters, must be viewed, I think, as finally fixing and settling the fundamental principles of glacier motion. I, for one, long entertained views opposed to the viscous, or better

called semi-fluid theory of motion, not so much, I can truly say, from having proposed another view, as from finding an insuperable difficulty in imagining a molecular condition in the mass of ice, such as to permit of differential motion, and yet maintain coherence in large and isolated masses. When at length the proofs of motion, strictly analagous to those of semi-fluid masses, were announced by Forbes, I could no longer withhold my assent to his conclusion, however incapable of seeing through my former difficulty. Since that, however, I have found in common loaf sugar, when moistened, a substance possessing fully the molecular conditions demanded, possessing a certain coherence, with permeability and capillarity for water, flexibility, and in tolerably large masses, semi-fluid motion; and I am now enabled with full conviction to embrace the views which Forbes has so beautifully and philosophically developed, and which I believe are expressions of the truth as in nature. That dilatation plays no part in glacier movement, and that hydrostatic pressure from beneath, while it is certainly occasionally an adjunct cause of movement, is generally one wholly subordinate, are, I think, also now proved.

The views which relate to the existence of a glacial period, have derived clearness and acceptability from the discussions of Mr. Lyell, founded on the acknowledged principles of climatology, first put in a distinct light by Humboldt. He has shown what vast changes of climate a new distribution of sea and land may produce, and such a view might probably even be pushed stilll further than he has ventured.

Professor J. Forbes also has indicated in treating of the great increase of the Alpine glaciers in 1846, how small and comparatively unnoticeable a change in climate, would, if continued for a lengthened period, produce an indefinite extension of glacier formations. The possibility of an ice period has therefore been at length proved, and the researches of Professor Edward Forbes, and of Mr. Lyell have made its occurrence a probability.

Lyell has shown that the coarser materials composing the carboniferous rocks of North America came from land lying to the eastward, and now covered by the Atlantic. Edward Forbes has shown, in his most able memoir in the Geological Survey of Great Britain, that the relationship betwixt the fauna and flora of the British Islands and of North America is such, that one has derived a certain proportion of its plants and animals from the other, or that both derived them from some common central land now sunk beneath the ocean that rolls between them. Now, when we examine the Wealden group of rocks, fresh water deposits of great extent and thickness, we are obliged to conclude, that once a river, greater than the Mississipi, had its estuary where England now stands. Such a river must have drained a vast continent, not less than 2000 miles across, and which probably once connected

America with the British Islands—then its shores; but such an unbroken mass of land may involve (dependent upon the character and elevation of its surface) the existence of great cold and rigour of climate, such as we find in fact at this day developed, though in mitigated degree, in Canada, which is vastly colder than Oregon, which lies in the same latitude, but at the western side of the American continent, or in central Russia, in latitudes the same as our own. We can, therefore readily admit that vast and widely spread icy regions may have and probably did exist formerly, where there is now a temperate climate on our earth. Within certain limits the converse also is equally true. Beyond this view the supposition of an universally extended ice period covering the whole earth, whether due to the passage of our system through regions of extremely low temperature, as conceived by Bessel and Poisson, or to any other conceivable machinery, must so far be considered as merely speculative. The precipitate generalization which called a universal glacial period into existence for the purpose of accounting for the transport of the vast masses of drifted or detrital matter, which occupy so large a surface of Europe and Asia, and it now appears also of North America, has already been found in this respect uncalled-for. Large as were the areas of observation of the earlier promulgators of the glacial or glacier speculations of transport, they were infinitely too small for the correct estimation of the phenomenon of transport, of the Scandinavian and Asiatic drifts (I use the word drift here merely as descriptive of the thing carried, and without reference to any special view as to the mode of transport.) The observations of Murchison and his collaborateurs, and subsequently in Norway, of Desor, the companion of Agassiz, have apparently at length convinced most geologists that glacier action, however widely extended, cannot account for the movement of the vast masses of detritus which cover so large a portion of the now dry land. The earliest view of drift transport was that of the debacle of older geologists, a view in which no clear idea of a fixed horizon of either land or sea was ever insisted on. This gave way to the glacial hypothesis upon which so very much has been said and written to so very little good purpose; and this again has been succeeded by a third hypothesis, the celebrity at least of which is chiefly due to its having been espoused by Sir Roderick Murchison, as a mode of accounting for the northern drift of Scandinavia, namely, the passage of what he calls waves of translation, and of which he has given an account in his memoir read to the Geological Society of London in April, 1846. The waves, here called waves of translation, are not so in the sense in which the term is used by hydrodynamic authors, but are rather breaking shore waves; and until geologists have more precisely distinguished the classes and respective phenomena of waves as a distinct branch of exact science,

and applied this to their subject, much good progress will not be made.

Mr. Whewell, in a paper read to the Geological Society of London, in January last, has in some degree cleared this subject, and certainly shows geologists the right mode of inquiry, though from neglect of conditions his paper loses much of its value. While his paper shows, that a wave of translation may be a translating or transporting wave of great power, I think it demonstates, without going farther, the extreme improbability of the great detrital masses of the now dry land having been mainly, if it all, carried by a mechanism which demands an extent and violence, and frequency of paroxismal action, of which we have no experience, nor any observation to lead us to suppose it ever formed part of the established machinery of our globe.

That waves of translation do occasionally, but rarely, as agents of transport, play a formidable part in breaking upon shores, or within soundings, as one of the phenomena of earthquakes we know, and the condition of their production, motion, and subsidence have been discussed in my own memoir on earthquake dynamics, but that they have ever been competent to the vast total efforts of transport of the American, European, and Asiatic drifts is far from being even indicated, and to assume this as a primal cause for such almost universally diffused phenomena as transported detritus presents, is to depart at once from that wholesome canon of geology, first broadly insisted on by our illustrious cotemporary Lyell—that we must first of all seek to account for the effects we observe in geology, by causes which we find now in operation, or which our experience gives us the analogues of; and in these, I do believe, will yet be found the full and sufficient explanation of all the phenomena of drifted formations. The actions of breaking waves in shallows and on shores, have been much confounded with those of the unbreaking waves of translation. The former are incessantly at work. Let their powers and their effects be studied with care, and above all in the clearness of exact science—let the results of their actions be connected with those of tidal and of ocean currents, as now known to exist, and connected also with such gradual or per saltum elevations, or depressions of the land, above or below the sea, viewed as a fixed horizon, as we have observed—and lastly, let all these be connected with the movements of loose materials, going on in the existing sea bottoms, by the fluency or semi-fluid motions of these vast masses of matter, reposing on inclined beds, which beds are themselves subject to changes of inclination, as well as to elevation and depression; and from the whole I am bold enough to venture a prediction, that no phenomena of transported materials, however vast, have yet been observed, that such a machinery will not be found sufficient to account for. In these, I believe, will be found the *vera causa* of northern and other great drifts—to the passage of

these mud glaciers, (to use this term again,) over surfaces of rock below the sea, may be traced the furrows and groovings as to which so much has been written, but which are now at length admitted to have been produced principally under water, and in all possible directions, neither universally accordant with tidal nor with glacier directions of motion, but with the slope of the rock beneath; and to these shore or breaking waves, may be attributed those gigantic cauldrons, (the Riesentöpfe,) of the Scandinavian rocks, which neither glaciers nor icebergs can throw any light npon.

But while I state my conviction, that the connected forces above stated, will yet be found to be the true and general cause of drift transport, I readily admit that icebergs cast afloat have been, as they are now, an occasional means of transporting a freight of foreign rocky, and other matter to vast distances; and may have been the carriers of many of our boulders found isolated to great distances from their originating rocks, but their powers seem quite inadequate to the gigantic task that has been affirmed of them as the universal drift carriers; the great operations of nature are always performed by forces steadily in action, yet others only called occasionally, or as it were accidentally, into play, do sometimes subordinately act in concert with, and, as it were, simulate the functions of these; and the remarks of Mr. Milne on this subject, as referring to the drifted materials of Scotland, seem to be conclusive, that iceberg action may here, at least in part, have heen the carrying agent.

As belonging to the subject of ice, some recent papers in the new Edinburgh Phil. Journal on glaciers, considered as manufactories of soil, though not free from some objection, are of much interest; as also the memoir of M. Collomb, on the colour of the water of glaciers, in which he shows this fluid, besides its mineral contents, must contain much vegetable, and even animal organic matter; the latter partly derived from the Desoria glacialis, or glacier flea, that singular insect inhabitant of desolation, discovered by the confrere of Agassiz, and named after him.

The subject of earthquakes, and of volcanic action, has not received any direct accession of importance during this year; but many papers of great value bearing upon such questions have been published, to which I can do little more than refer. Earthquake motions have within two years been brought within the domain of exact science, and every advance made in the theory of elastic waves in solids and liquids must hereafter be viewed as an advance in physical geology. The memoirs of M. Wertheim, on waves of sound in water, are in this respect worthy of our attention as well as the profound researches of our countryman, Mr. Haughton, published in the last volume of "Transactions of the Royal Irish Academy."

I cannot avoid congratulating the Society upon its recent election of Mr. Haughton as one of its members, and expressing a lively

hope, in which I am certain every working geologist here joins me, that he will devote at an early period a portion of his investigations on waves to the doctrine of elastic waves, as applied directly to the observed phenomena of earthquakes.

It has been long a debated point, whether meteorological conditions at all affected earthquake phenomena. Babbage long since suggested, that barometrical changes might have some influence. This question has been since discussed by M. Perré, in an able memoir on the influence of the moon upon earthquakes; and our ideas have been advanced also by the publication of Major Sabine's important paper on the diurnal lunar atmospheric tide at St. Helena, where he finds there is an aerial tide amounting to .004 inches of the barometer, when the moon is on the meridian above or below the pole. The existence of such atmospheric tides, when synchronising with other large barometric changes, shows that meteorological data cannot be hereafter, perhaps, wholly neglected in questions of earthquake dynamics.

There have been several great earthquakes during the last year, and that preceding. Daubree has given account of that very singular one occurring upon the Rhine on July 26th, 1846. This earthquake was experienced over a large part of Germany—Belgium, Switzerland, and Bavaria, and into France. Its effects on the Rhine appear to have been complicated with landslips. Daubree suggests that the many earthquakes which occur about this period form parts of one great operation, of movement, felt in various places.

On 25th July in Turkey, and Asia Minor.

On 10th August in neighbourhood of Naples.

On 14th and 17th August in Tuscany.

On 17th and 18th August in Switzerland.

Pilla has recorded many facts of great geological value in his account of the great earthquake in Tuscany in May, 1846; and I may add, that many of the facts which he gives confirm the views of earthquake motion, which I have promulgated, and several not accounted for by him may, by the light of these theoretic views, be readily explained.

Paoli Savi has also published a small volume, "Relatione dei Terremoti de Toscana, dell Agosti, 1846," printed at Pisa. M. Darlu has described a few of the phenomena of the great earthquake at Copiabo, on the 19th January, 1847, and M. Marchant that at Fecamp, on the 10th July last. There have been many minor earthquakes recorded, several in our own islands.

Indeed, now that the attention of geologists is beginning to be directed for the first time with any pretension to system, or with the help of a guiding theory to this subject, it begins to be plain that earthquakes of various degrees of intensity are almost of daily, perhaps even of still more frequent occurrence. What a rich field

of physical discovery the prospect of carefully observing and recording the directions and motions of these wonderful waves of force, thus constantly traversing the solid but elastic mass of our globe, presents—what important accessions to our knowledge may not the power of finding their origins, both in regard to surface and to depth, be expected to give to terrestrial physics.

At the late meeting, at Oxford, of the British Association, for the Advancement of Science, a Committee was appointed, with a grant of £50 at its disposal, for the construction of self-registering instruments for earthquake shocks, and for their erection where it may be deemed advisable. The perfecting of such instruments, in which some progress has been made towards actual construction, is one of the first steps towards such an end, and we trust to be able to report our progress at the ensuing meeting at Swansea; but experiments on the elastic moduli of rocks are our most pressing and indispensable requirements.

As connected with volcanic action proper, Lecloiszeau has published an extremely interesting paper on the temperature of the waters of the Geysers of Iceland, which he experimented on in the July of last year, along with Professor Bunsen, of Marbourg. Their thermometrical results have probably advanced our knowledge of the machinery of these wonderful objects more than all previous treatises. They found that the column of hot water close to the bottom, or lowest attainable point of the tube, at a depth of about twenty-three metres, in the great Geyser, possessed a maximum temperature shortly before, and a minimum temperature shortly after the time of eruption. They also find by calculation, that the temperature due to ebullition under the head of water of the tube is, from 9.151 deg. to 12.612 deg. cent. higher than the actual observed temperature of the lowest part of the column previous to an eruption. 136.151 deg. cent. being the calculated point of ebullition when the basin is full. From this it follows, that before an eruption, the fluid is far below the boiling point, even where hottest, and from these data, they conclude, that the intermittance of eruption is due to a supply of water occurring near the mouth of the tube of eruption, which they suppose to be long and sinuous. As it leads downwards the heated region, in which the volumes of steam and heated gases, which constantly escape through the water, are formed; by the passage of these, the comparatively cold water is gradually heated by their condensation, (producing the "secouses" constantly heard); as it becomes less capable of condensation, the tension of these vapours and gases increases, until at length it overcomes the statical pressure of the liquid column and of the atmosphere, and an eruption follows. The phenomena, as observed at the other large Geyser—the Strokkur—are quite analagous, but less marked.

In a lengthened paper by Mr. J. D. Dana, on the volcanoes of the

moon, in which he takes a survey of all our existing knowledge, astronomically derived, of the moon's surface, occur some valuable observations upon the comparison or relation of terrestrial volcanic vents, with the ring craters, or supposed volcanic vents of the moon. He shows that we have, though on a diminished scale, analogues to the lunar ring craters—as for instance in the Kilanea volcano in Hawaii—where a vast crater-bottomed plane of solid lava is still penetrated by open and fiery vents. Perhaps, however, the most important parts of this paper are the author's discussion of the constancy of the sea level, as a fixed geological horizon, and of the views of M. Prevost in relation to this, and to the formation of ocean beds by subsidence due to unequal contraction. Amongst the researches in physics applicable to geology, besides those papers already noticed under the head of earthquakes, is the elaborate memoir of M. Caldecot, on the variation of the temperature of the earth at Travancore, on the Malabar coast, from observations continued from the year 1842 to 1845, and published in the Memoirs of the Royal Academy of Belgium. Nor should we omit wholly to notice the magnificent volume just issued descriptive of the measurement of the base line at Londonderry, by the Officers of the Ordnance Survey of Ireland.

Geology, as referred to chemical action, has received some most interesting additions.

MM. Boussingault and Lewy, have analysed the waters of the Acid River, Paramo de Ruiz, in New Granada, and of the Vinegar River, or Passambio, whose source is from the volcano of Puracè—both rivers contain prodigious quantities, both of sulphuric and of hydrochloric acids, in a free state, and no small part combined with earthy and metallic bases. Guaging the volume of water in the month of April, 1831, in the former river, they find, by calculation, that it discharges every twenty-four hours the almost incredible volume of

38.611 Kilogs. of Sulphuric Acid, and
31.654 Kilogs. of Hydrochloric Acid.

When we consider that this enormous volume of potent chemical agency, is thus daily discharged from a single stream, originating in a single volcano of the Andes, that the statement takes no account of the probably as large or larger volume of acid vapours discharged uncondensed from this one volcano, and that every volcano on the earth's surface is, in proportion to its size, equally active; we cannot avoid amazement at the prodigious powers of chemical change that are daily in action, as part of the common regime of our globe, and feel our convictions strengthened, that cataclysms play little part in its history.

In direct connection with this subject is the research of M. Langlois on the action of sulphurous acid on the alkaline monosul-

phurets. These he finds are converted into hyposulphites, with deposition of sulphur. This reaction most probably is that to which is due the large portion of the sulphur deposited near volcanic centres.

Professor Graham's researches on the action of sulphuretted hydrogen upon moistened hydrate of lime, and on the subsequent changes which result in the conversion of a large portion of the mass into hyposulphites, connect themselves with interest to those of Langlois.

It would be a highly important question to geology, to pursue this research in determining what would become of the hyposulphites formed, when exposed to the usual great agents of surface decomposition—air, water, carbonic acid, and organic matter.

The observations made by Darwin as to the saline matters, occupying the salt plains of South America, seem to point to slow re-actions of this sort, ultimately determining the formation of alkaline carbonates and nitrates.

A wide field of geological research, in which chemistry must play a chief part, remains as yet almost untouched, connected with these questions, namely, the affinities that have operated, and the changes that have taken place in elementary composition in the deposits of the salt formations. Gypsum and sea salt are well known as here associated with the variegated marls. Sulphate and chloride of iron have also been noticed with iodides and bromides, some magnesian salts, and as Dumas observed, carburetted hydrogen in a state of extreme condensation in the cavities of crystals of the sal gem; in fact all the elements of sea water, but strangely mixed, changed and mutually decomposed.

A new mineral, Martensite, has been recently described by Kersten, composed of chloride of sodium, and anhydrous sulphate of magnesia, from the salt beds of Stassfurth; and M. Jules Bouis, has found at the salt pits of Titou, in the department of Aude, a bed of solid sulphate of magnesia, of nearly three feet in thickness, in fibrous crystals, containing 48.32 per cent. of water, cutting right through the beds of gypsum. Every thing in the salt formation indicates turbulent action, and mutual decomposition, and recomposition upon the grandest scale. Perhaps no one department of physical geology is less known than this, and the elucidation of its intricate phenomena, upon which so much other information to geology depends, must be commenced by the chemical philosopher, before whom shall be placed for analysis suites of carefully collected and selected specimens of all the minerals found in given saline formations. Analysis of all the salts from the salt plains of Asia and South America, would be equally important, in relation to the ulterior surface decompositions of marine salts daily going on.

Dumas has also added some valuable observations to this branch of geology. He finds that whenever sulphuretted hydrogen is per-

mitted to evolve slowly into the atmosphere, in contact with porous bodies, it is converted into sulphuric acid. We have thence another source of free sulphuric acid independent of volcanic action at work throughout the tropics, indeed throughout all nature.

What is equally important as a geological fact, he finds that ammonia, one of the constant products of animal putrefaction, is under analogous conditions converted into nitric acid. These results coincide with those of M. Kuhlmann on nitrification, and throw great light upon the conditions of geological formation of the saline deposits of Africa, Central Asia, and South America.

Though not published within our year, the two works of M. Riviere, on the chemistry of lithological geology, viz.—" Memoire Mineralogique et Geologique Sur les Roches dioritiques de la France Occidentale," and "Memoires sur les Feldspaths," both octavo volumes, as well as his several papers on the subject of the chemical constitution of the nonstratified rocks, demand special notice. He has shown that the amphibolic rocks, that is to say, those in which amphibole enters as an essential element, divide themselves naturally into two groups, as well with respect to their mineral constitution as to their special positions, and to the epoch of their formation. The first group comprehends those in which amphibole of the hornblende type is associated with feldspar of the albite type. The second group embraces those in which the contained amphibole of the hornblende type is associated with feldspar of the orthose type.

To the first group the dioritic rocks belong, and to the second the syenitic. Riviere has also shown the relations that subsist between the amphibolic and pyroxenic rocks, the diallages and hypersthenes, the talcose and the serpentinic rocks, seeking to establish a general relation between the prevailing type, or mineral of the rock, its proportion of silex, or of oxygene, and its antiquity. The whole view is founded upon a careful and profound study and classification of the feldspars, and leading the author to an ultimate generalization, that non-stratified rocks of the same age have the same chemical and mineralogical composition, and reciprocally that when these are the same the rocks are of the same age. However accordant with the truth in nature this may be, it is premature to decide, if even the generalization itself be not premature; but the scaffolding upon which it has been built, is of enduring value, either to complete this edifice, or remodel it to another.

In a different application of chemistry to geology some very beautiful additions have been recently made—namely, in the artificial formation of simple minerals or pyrogenous rocks.

M. Ebelmen has struck out a new method of pyrognostic enquiry, founded upon the use of certain very fusible bodies, such as boracic acid, which react but little upon various earthy and metallic bases, and yet permit the mutual reaction of these, when all fused together,

the fluid boracic acid acting merely as a solvent for the rest; but further, as boracic acid and certain of its compounds are slowly volatile at high temperature, this solvent flies off gradually, and as when a watery solution is slowly evaporated, its saline contents are left in a crystalline form, so does Ebelmen find that earthy bases and oxides the most refractory may be caused to react mutually, when dissolved in these his fiery fluids, and by the evaporation of the latter their compounds left in a crystallised state. Operating thus with suitable mixtures the sagacity and ingenuity of the French chemist have been rewarded by the production in the porcelain oven of perfect crystals of the ruby, the spinelle, and the sapphire, possessing all the chemical and physical characters of these natural and highly prized gems. These first essays in a line of experiment wholly new and capable of almost indefinite extension, and offering such direct and striking analogies to the conditions of igneous action in nature, when pursued, must greatly enlarge our pyrognostic geology.

M. Delesse has also published a valuable memoir upon the changes of density and volume, consequent upon the fusion of the igneous rocks a second time, when they assume the glassy structure. His most general result is, that "when these rocks pass from the crystalline to the vitreous state, they suffer a diminution of density which, cæteris paribus, is greater, as they contain more silica and alkali, and conversely is less in proportion, as they contain more oxide of iron, lime, and alumina."

Geologists may also take some hints, not without value, from the singular process, for the manufacture of artificial stone, invented by Mr. Ransome, of Ipswich, in which silica reduced by the action under a high pressure of a caustic alkaline solution is afterwards mixed up with siliceous rock into a paste, and the whole submitted to pressure and baking, a process by which it is stated, that even grind stones may be formed, and building stones, and lithic masses of statuary of the greatest hardness and beauty, and capable of the finest polish. The stone (specimens of which I have seen) presents all the external and physical characters of a natural quartz rock.

By far the most important advance lately made in our molecular knowledge as applied to geology is that of Mr. Sharp, by his discussion of the conditions of slaty cleavage. He has done much to clear this important subject of the empiricism of former experiments, who have sought to force galvanism into their service, and from very immature and slender experiments, attributed cleavage to some occult actions of these forces. Mr. Sharp does not pretend to have wrought out his subject; but has apparently established the fact, that pressure at right angles to the planes of cleavage is uniformly concerned in the production of lamination. His views present some analogy to those before suggested by M. Darwin. To complete the solution, however, of this difficult problem, it will be

necessary not only to extend our knowledge of the actual facts of cleavage further, but to take into consideration the original circumstances of deposit of the stratified rocks, the molecular condition of their constituents before their induration, and the forces, whether crystalline or otherwise, that have acted upon them, and at various temperatures, and for lengthened periods.

The views of Doctor Scheerer, published during last year, on the subject of isomorphism and isomerism, are worthy the regard both of mineralogists and geologists. I can only allude, however, to them.

Some exceedingly interesting cases of mineral pseudomorphism have been recorded during the year. Haidinger has found on the surface of certain meteoric stones crystals of pyrites and of graphite, and the crystals of the latter are pseudomorphs of the former—combinations of the cube and of the rhomboidal dodecahedron.

Kersten has recorded crystals of serpentine from Schwartzenberg, in the beds and form of garnets, removed by some unknown solvent agency.

Marcel de Serres and Figuer have published an interesting memoir on the state of shells found petrified in the bed of the Mediterranean, of a recent period, in which they show that in the double relation of chemical composition and mode of petrifaction the shells preserved in the bottom of the sea are in every respect like those of the tertiary formations—the chief difference being in the more crystalline texture of the recent shells. Oysters, pectens, venus, pectuncula, and cardiums have been investigated by them, both in the tertiary and recent formations.

Last year a good deal of discussion was excited in this Society on the subject of a notice brought before it of shells, stated to have fallen during a thunder shower in the county of Carlow. I therefore just notice here that M. Dapasquier has given an account very recently of a shower of earth, occurring in the department of Drome in France, the particulars of which will be found in the Comptes Rendú for April last.

In descriptive and topographic geology, numerous memoirs have appeared, which time will not permit me to allude to. Hombres de Firmas on new Terebratula, Elie de Beaumont on the Geology of Morocco, Tallavigne's Researches on the nummulitic formations of the Aades and the Pyrennees, are amongst these.

Palæontology has received rich accessions in the memoirs of Joly and Leymerie, upon the nummulites, the singular animals inhabiting which they consider not to have been a polipe, properly so called, nor a medusa, nor an annelide, nor a cephalopod mollusc—but one of those beings so long misunderstood, for which D'Orbigny has created the name of Foraminifera (the Bryozaires of Ehrenberg.) The nummulites had external multispiral polythalamic shells enveloping a central spire—all the chambers were occupied by the

animal at once—locomotion and prehension were produced by tentacula, and its increase of size was due to the production of new segments in the plane of the previous ones.

The much debated question of transmutation of species in time, has received an able illustration in Professor E. Forbes's paper on the tertiaries of the island of Cos, in which he clearly shows how change of physical condition, gradually introduced, shall first alter the forms and development of species, while further changes as to physical condition occurring more suddenly, shall so revolutionize the fauna as to present those modes of variation in the mollusca which once were supposed only accountable for by a transmutation of species. Lastly, we have had published in the Transactions of the Zoological Society of London, the magnificent memoirs of Professor Owen, upon the Apterix of New Zealand, and upon its gigantic fossil prototypes, the Dinornis and Palapterix, characterised by the possession of a back toe.

No remnant of the Dinornis has yet been found in any of the islands contiguous to New Zealand, nor in Australia. "The extraordinary number of wingless birds, (says Professor Owen,) and the vast stature of some of the species peculiar to New Zealand, and which have finally become extinct in that small tract of dry land, suggest it to be the remnant of a larger tract or continent over which this singular struthious fauna formerly ranged. One might almost be disposed to regard new Zealand as one end of a mighty wave of the unstable and ever shifting crust of the earth, of which the opposite end, after having been long submerged, has again risen with its accumulated deposits in North America, showing us in the Connecticut sandstones of the Permian period the foot prints of the gigantic birds which trod its surface before it sank, and to surmise that the intermediate body of the land wave along which the Dinornis may have travelled to New Zealand has progressively subsided, and now lies beneath the Pacific Ocean." How well this squares with the views of Professor E. Forbes, as to the ancient land of the Atlantic.

We may remark that the Apterix like the Dodo (upon the character and classification of which Professor Owen has published a memoir consequent on his recent examination of the remains at Oxford) will soon be extinct in New Zealand, and add another to the many proofs we have of the extinction of species, due to their imprisonment in the restricted insular remnants of their once more extensive domains now sunk beneath the sea.

On mature examination of the Oxford remains of the Dodo, Professor Owen is disposed to consider the bird to have belonged to an extremely modified form of the raptorial order, and to have fed either on dead organised matter, or upon reptiles and littoral fishes, crustacea, &c.; there seems to be since, however, reason to modify this conclusion. His suggestion as to the value of careful and

diligent search for bones, &c., of the Dodo in the alluvium of the Mauritius and Rodrigues islands deserves to be as far as possible published.

Our national geological collections have very recently received a most valuable addition in a great number of bones of the dinornis and palapterix, sent home by Dr. Mantell's son from New Zealand, and presented to the Geological Society in London. These include many bones of the legs, which, from the non-adhesion of the epiphyses, are proved to have been young birds, chickens in fact, of about thirteen feet in height. The mandibles of some of these gigantic creatures, and several fragments of their enormous egg shells have also been received. The shape of the powerful bill, and the other characters of those animals induce Professor Owen to conclude that they fed chiefly on vegetables and roots. It is a singular circumstance that no portion of the rudimentary wing bones have heen found amongst the many hundreds of other bones of these huge birds sent home.

We should also notice the discovery of fossil vertebrated animals in the older stratified rocks, those below the coal measures, in America—Batrachian reptiles of enormous size—frogs, in fact, of twenty feet in length, whose foot-prints we find embedded in the now indurated rock that was once the soft mud over which these creatures roamed.

The recovery of some fragments of bone, has enabled Owen to build up again the contour and structure of this enormous brute, upon which M. Lyell has recently made some interesting communications.

Botany has received rich accessions to its publications, in our member's (Doctor W. H. Harveys) continuations of his great work upon the algæ of the Southern Ocean, and those of northern countries; and also in Dr. Hooker's beautiful botany of Sir J. Clark's antarctic voyage.

Only one of our members has died during the past year. Samuel Litton, M.D. was born in Liverpool, where he was also educated while a boy. His parents were wealthy and of good family, being related to the Clives. His father, who is stated to have possessed some learning and scientific knowledge, was the friend of the late Archbishop Magee, at whose representations, due to the precocious talents exhibited by the lad, his father sent him to Dublin, and he entered Trinity College at fourteen years of age. His undergraduate career was honourable. His original destination for orders, in the Church of England, was abandoned, through certain religious scruples, subsequently themselves abandoned; and after having been a resident master, he took a medical degree of the University of Dublin. For some years he remained the intimate, and in some degree, the pupil of the late Doctor Halahan, (one of those names which Irish medical history recalls with pride;) and at subsequent

periods held the chair of Natural Philosopy and Chemistry, at the Dublin Institution, where the Duchess of Richmond and Lady Manners, were attentive hearers of his eminently popular lectures to his large class, and afterwards the Professorship of Botany to the Royal Dublin Society, an appointment which he occupied until his death, which was sudden and unexpected. He was also physician to the House of industry while it existed, but appears to have practised little generally in medicine.

Doctor Litton has left few records of original investigation; though one of the best informed men of his day, a natural inaptitude for observation was remarked by his intimates, which may have led to this—yet he abounded in almost universal information; so much so, that while librarian to the Royal Dublin Society, he was familiarly known to his learned associates there by the title of the "walking index." In converse and private life, his temper and disposition were equable and kindly; and his intimate friends were edified by his fervent and unostentatious piety.

Geology has also sustained a loss in the death of M. Alexander Brogniart, in October last, and whose European reputation demands this passing tribute to his memory as a philosopher, as well as to that of Daubuisson de Voisins, whose necrology has only just been published, although he has been dead some years; a man combining the rare accomplishments of the mathematician, the physicien, the engineer, and the geologist.

Since our last aniversary meeting an important change has taken place in the external condition of our Society; the apartments which we for some time held, by permisssion of government, in the Custom-house, have been taken from us, to accommodate the enlarged wants of the Poor Law Commissioners. Into the detail of this transaction, and the changes it has involved, I shall not enter, as they have been laid before the Society in the report of Council. Yet I cannot help remarking, that our sudden and peremptory extrusion from the Custom-house for the accommodation of a subordinate branch of the public service, possessing no more inherent right to apartments there than ourselves, has evidenced a disregard on the part of the government authorities in England, of public opinion amongst the learned classes in this country, which certainly would not have been ventured upon or tolerated with respect to the Geological Society of London, if under similar conditions it had been proposed to eject that Society from the apartments it has long occupied, by sufferance, in Somerset House.

If possibly, in this measure towards our Society, her Majesty's officers have been influenced in any degree by the view, that in founding a museum of economic geology in Ireland, they have sufficiently provided for the future advance of geology as a science, there has been a grave mistake. Already, indeed, has that museum changed its views, and expanded its title to the Museum of Irish industry,

thus giving up, even in name, any direct connection with geology. Under any circumstances, such an Institution may diffuse the knowledge of the facts of geology as applied to the arts, but can never advance it as a science. We therefore still submit, that we have a claim upon public grounds upon her Majesty's government, to bestow upon us an equivalent for our late apartments, which may still be done by enabling us, by a grant of money, to extend our geological library.

Meanwhile our arrangements have enabled us to meet within the time-honoured walls of our University, and even in some degree to connect our progress with its system.

We doubt not that the connection will be to the advantage of geological science—that the views of Bacon, as to the success that shall attend the working of different minds, kindred in spirit, but various in power, in discipline, and in attainment, will, in our future progress, be here efficiently realised, and be not without fruit.

Finally, in resigning this chair to my able successor and excellent friend, Professor Oldham, I have to express to the Society my abiding sense of the unmerited honour which placed me in it—my thanks for the courtesy and kindness with which I have been encouraged and received by every member of the Society—and my apology for the many deficiencies in the fulfilment of my office of which I am but too painfully conscious. In so far as I have done well, I have done according to my wish; in anything that may have been otherwise, according to my ability.

March 8th, 1848.—"On the geology of part of the County of Wicklow," by PROFESSOR OLDHAM, Director of the Geological Survey of Ireland, President of the Society.

In this communication the geological structure of the district, which includes Lugnaquilla, Glenmalur, Glendalough, &c., was described in detail, and illustrated by a reference to the large townland maps of the country referred to. Glenmalur was more particularly pointed out, as exhibiting on a large scale, and in greater perfection and clearness than any other portion of the country, the well-marked, and very interesting phenomena which occur along the junction of the granite and slate rocks. Here the two rocks become so curiously and largely intermixed, masses of slates of all sizes, from a few feet to half a mile in length, being caught up in the granite, and veins of granite of various extent traversing the slate in every direction that on a large view it might almost be described as a breccia of granite and slate.

The granite intrusions having in most cases assumed the direction of the lines of least resistance, or along the planes of lamination of the slates, an erroneous idea of the bedded nature of the granite might very easily result from a cursory examination. The slate rocks are all very highly altered; in many cases rendered perfectly crystalline, though still retaining all their laminated character.

The structure of Lugnaquilla was also shown, and the occurrence of a remarkable series of mountain lakes, at nearly the same elevation round the flanks of the hill, pointed out, together with the probable mode of their formation. The occurrence of faults traversing the hill, and in the glen, was also shown; and their effects on the metalliferous lodes which occur in the neighbourhood.

The paper was illustrated by the sections and maps of the Geological Survey of Ireland.

April 12th, 1848.—"On certain molecular changes occurring in the structure of recent shells," by R. MALLET, Esq., M.R.I.A., &c.

Along the shores of Belfast Lough, a little eastward of Carrickfergus, low cliffs of red and gray marl occur, and beds of same dip under low water mark on the beach. Imbedded in the latter, are fragments of gypsum, and various recent shells. Of these, oysters are the most common. On extracting and examining some of these, the author found that the surfaces of the shells, and most of the interstitial cavities were filled, or in process of filling, with calcareous spar; and in those shells in which this process had gone on longest, the entire substance of the shell had assumed more or less perfectly

the crystalline form of calk-spar, the shorter axis of the rhombs being perpendicular to the original nacreous plates of the shell. The filling up of interstices with calk spar, or with arragonite, is common, but the author is not aware that this induction of molecular action, the change of the whole substance of the shell to the same crystalline form, as that assumed by the carbonate of lime filling the cavities, has been before noticed. The structure of organised bodies in progress of fossillization, appears to influence the crystalline form of the fossillizing substance. Thus belemnites appear always, so far as the author has remarked, to be fossillized by lime in the form of arragonite.

The author presented a specimen of ostrea, altered in the above form, along with this notice of one of a class of very little regarded, but interesting phenomena, which, if better observed and discussed, through a large range, would probably add to our very scanty knowledge of the conditions of fossillization.

"On the 'drift' deposits of the County of Wicklow," by THOMAS OLDHAM, Professor of Geology in the University of Dublin, President of the Society.

The author gave a detailed description of the general character, composition, and arrangements of the more superficial deposits, which cover a large area in the County of Wicklow, and which have been generally classed under the name of *drift*. He showed how inapplicable this term was to much of these deposits, they being obviously tranquil and long continued depositions of fine matter, containing frequently perfectly preserved marine shells. With these deposits of fine marl and clay, are frequently associated layers of sand and fine gravel, perfectly laminated and regularly bedded. The general variation in the character of these deposits, traceable in passing from the north of the County southwards, was also pointed out. Perfectly distinct from, and in all cases subsequent to, these marl and clay deposits, containing marine shells, is the great boulder deposit of Wicklow. The general arrangement, size, and character of these boulders was shown.

The greatest elevation above the sea level, at which sea shells had been found, was about six hundred feet. Gravel, formed principally of much rounded pebbles of limestone, had, however, been found at elevations of nearly one thousand feet above the sea.

The remarkable fact of several of the glens in Wicklow, occurring at much lower elevations than that at which these gravels occur, and surrounded on all sides by these gravel deposits, having yet no trace of it in the glens themselves, was pointed out.

The very important influence which these gravels and clays exert on the agricultural character of the district was also shown, and illustrated by detailed maps representing both the values per acre, and the character of the soils.

The paper was illustrated by a map showing the area covered by these deposits, and by sections.

The University being occupied by her Majesty's troops, in consequence of the disturbed state of the country, the meetings of the Society for May and June, were suspended.

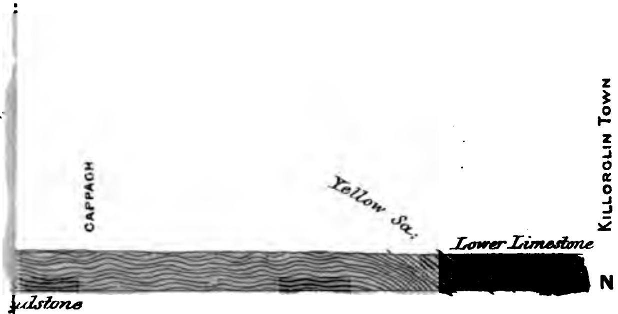
INDEX

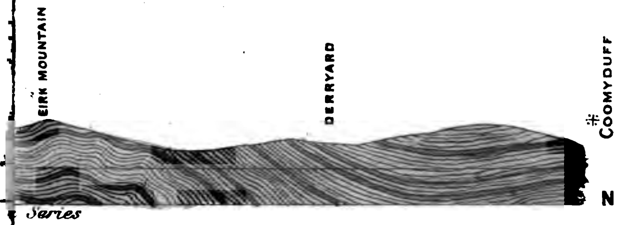
TO

VOLS. I. II. & III.

The numerals refer to the volume—the figures to the page.

HE COUNTY OF KERRY. —





DE OF THE GAP OF DUNLOE.

N

March 1846. Richard Griffith